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X-29A Longitudinal and Directional Force and Moment Supplemental Transonic Wind Tunnel Test Results

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SUMMARY

Aerodynamic data from NASA Ames Research Center's 11-Foot Transonic Wind Tunnel are plotted for the 1/8-scale X-29A forward-swept wing aircraft model. Eleven configurations were tested to provide supplemental data to investigate single surface failure modes, complex nonlinearities, and model buildup.

These data can be used for control system refinements, pilot training, flight planning, and aerodynamic model validation. Data are presented as corrected wind tunnel data without analysis to document results that are being used for the aerodynamic model.

INTRODUCTION

The X-29A aircraft is a research vehicle that is scheduled to be used for a manned flight demonstration of forward-swept wing technology. Program objectives include advances in aerodynamic, structural, and flight control technologies. This aircraft can provide new design options for future military and commercial aircraft.

In May 1982, a wind tunnel test (number 538-1-11) was conducted in the NASA Ames Research Center's 11-Foot Transonic Wind Tunnel (ref. 1). This test provided an aerodynamic baseline data set for the X-29A aircraft. To supplement these data, a second test was conducted in July 1983 in the same wind tunnel. A 1/8-scale X-29A model was used for both of these tests (ref. 2). Wind tunnel corrections for both tests are identical.

This report documents the second wind tunnel test, number 577-1-11. Pertinent simulation packages and corresponding technical publications tests are detailed in the appendix. Configurations in test 577-1-11 included single control surface failure modes in the flaps, canards, and strakes, and nonlinearities in sideslip and high-angle-of-attack characteristics. Additional information on model buildup was also obtained. These data will be used for control system refinements, pilot training, flight planning, and aerodynamic model validation. Data are presented as corrected wind tunnel data without analysis.

NOMENCLATURE

ALPHA	angle of attack, deg
BETA	angle of sideslip, deg
BL	buttock line
CD	drag coefficient, stability axis
CL	lift coefficient, stability axis
CLL	rolling moment coefficient, body axis

CLMS	pitching moment coefficient, body axis
CLN	yawing moment coefficient, body axis
CYS	side force coefficient, body axis
DC	canard deflection, deg (both left and right in unison
DCL	left canard deflection, deg
DCR	right canard deflection, deg
DF	flap deflection, deg
DFIL	left inboard flap deflection, deg
DFIR	right inboard flap deflection, deg
DFOL	left outboard flap deflection, deg
DFOR	right outboard flap deflection, deg
DR	rudder deflection, deg
DS	strake deflection, deg
FS	fuselage station
RUN	wind tunnel run number
WL	waterline

MODEL CONFIGURATIONS

Changes in inboard flap, outboard flap, or rudder deflection were considered to be new configurations. The 11 designated configurations tested are shown on table 1. Configurations 1 through 9 are for aerodynamic data, and configurations 10 and 11 are for model buildup. Independent external control of the model's left and right canards allowed symmetric or asymmetric deflections, or both, during each wind tunnel run. All other control surfaces required stopping the tunnel and manually changing the model.

DATA PRESENTATION

All of the figures in this report are grouped according to configuration. The figure number and corresponding configuration, along with the test conditions, are presented in table 2. The run numbers are as specified in wind tunnel test number 577-1-11. For each figure there is an (a), a (b), and a (c) part for one set of wind tunnel runs. The (a) figures contain the lift coefficient (CL) vs. angle of

attack (ALPHA) or rolling moment coefficient (CLL) vs. angle of sideslip (BETA) plots; the (b) figures contain the drag coefficient (CD) vs. CL or yawing moment coefficient (CLN) vs. BETA plots; and the (c) figures contain the pitching moment coefficient (CLMS) vs. CL or side force coefficient (CYS) vs. BETA plots. All moments are about fuselage station (FS) 454.27, waterline (WL) 66 and buttock line (BL) 0. Aircraft reference wing area, span, and chord were 17.196 m^2 ($18ft^2$), 8.294 m (27 ft), and 2.200 m (7 ft), respectively.

CONCLUDING REMARKS

Aerodynamic data from NASA Ames Research Center's 11-Foot Transonic Wind Tunnel are presented for the 1/8-scale X-29A forward-swept wing aircraft model. This test, number 577-1-11, was conducted to provide supplementary data to investigate single surface failure modes and complex nonlinearities. Information on model buildup are also presented.

These data can be used for control system refinements, pilot training, flight planning, and aerodynamic model validation.

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Edwards, California 93523, June 21, 1983

APPENDIX - SIMULATION PACKAGES AND TESTS

This report documents the basic force and moment used to supplement the AERO5 and AERO6 simulation packages. A brief discussion of simulation packages is given below.

AERO 3: This simulation package is dated Oct. 11, 1982 (ref. 3). The data analysis and wind tunnel results are from an early design and have subsequently been corrected for the current design. The trimmed and linearized derivatives have been previously presented (ref. 4).

AERO 4: This simulation package is dated Sept. 19, 1983 (ref. 5). These data use wind tunnel test results from the current configuration in normal operations.

AERO 4A: This is a Mar. 30, 1984 revision (ref. 6) to AERO 4.

AERO 5: This simulation package is dated Dec. 9, 1983 (refs. 7 and 8). These data detail the flexible, nonlinear aerodynamic math model for canard and strake failure modes.

AERO 6: This simulation package (ref. 9) is dated Apr. 4, 1984. These data detail the flexible, nonlinear aerodynamic math model for flaperon, canard, and strake failure modes.

AERO 6B: This is a Mar. 30, 1984 revision (ref. 10) to AERO 6.

REFERENCES

1. Charletta, R.: Series 1 Transonic/Supersonic Documentation Testing on a 12.5% Scale Grumman Design 712, X-29A Model in the NASA-ARC 11 Foot and 9 x 7 Foot Wind Tunnels. AER/T-PT-199, Grumman Aerosp. Corp., Apr. 1982.

2. Charletta, R.: Series 1 Transonic/Supersonic Testing on a 12.5% Scale Grumman Design 712, X-29A Forward-Swept Wing Demonstrator Model in the NASA-ARC 11 Foot And 9 x 7 Foot Wind Tunnels at Moffett Field, CA. AER/T-AMES-538-1-11, 97, Vols. 1, 2, and 3, Grumman Aerosp. Corp., Aug. 1982.

3. Savatteri, C.; and Zigomalas, A.: X-29A Linear Flexibilized Longitudinal and Lateral-Directional Data Package. 712/ENG-M-82-475, Grumman Aerosp. Corp., Oct. 1982.

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5. Frei, D.: X-29 Flexible, Non-Linear Aerodynamic Math Model (AERO 4); Simulator Check Cases. 712/ENG-M-83-475 REV-A, Grumman Aerosp. Corp., Sept. 1983.

6. Frei, D.: X-29 Flexible, Non-Linear Aerodynamic Math Model: Equations and Computer Subroutines - AERO 4 - Revision A. 712/ENG-M-83-367 REV A, Grumman Aerosp. Corp., Mar. 1984.

7. Salimando, S. C.: X-29 Flexible, Non-Linear Aerodynamic Math Model for Canard and Strake Failure (AERO 5); Data Tables. 712/ENG-M-83-744, Grumman Aerosp. Corp., Dec. 1983.

8. Salimando, S. C.: X-29 Flexible, Non-Linear Aerodynamic Math Model for Canard and Strake Failure; Equations and Computer Subroutines - AERO 5. 712/ENG-M-83-739, Grumman Aerosp. Corp.; Dec. 1983.

9. Frei, D.: X-29 Flexible, Non-Linear Aerodynamic Math Model for Flaperon, Canard, and Strake Flap Failure: Limited Flight Envelope Simulator Check Cases - AERO 6. 712/ENG-M-84-106, Grumman Aerosp. Corp.; Apr. 1984.

10. Frei, D.: X-29 Flexible, Non-Linear Aerodynamic Math Model for Flaperon, Canard, and Strake Flap Failure: Equations and Computer Subroutines - AERO 6 - Revision B. 712/ENG-M-84-029 REV B, Grumman Aerosp. Corp., Mar. 1984.

TABLE 1. - AIRCRAFT CONFIGURATIONS

Configuration	Canard	DFOL, deg	DFIL, deg	DFIR, deg	DFOR, deg	DS, deg	DR, deg
1	on	0	0	0	0	0	0
2	on	15	15	15	15	varied	0
3	on	25	25	25	25	varied	0
4	on	25	25	-5	-5	0	0
5	on	0	0	-5	-5	0	0
6	on	10	10	-5	-5	0	0
7	on	15	15	-5	-5	0	0
8	on	0	15	15	0	0	0
9	on	10	10	10	10	0	-20
10	on	(wings and vertical removed)					
11	off	(wings removed)				0	

TABLE 2 - FIGURE CONFIGURATIONS AND TEST CONDITIONS

Figure	Config-uration	ALPHA	BETA	DCL	DCR	DS	MACH
1	1	-4,22	0	varied	varied	0	0.6
2	1	-4,22	4	varied	varied	0	0.6
3	1	-4,22	8	varied	varied	0	0.6
4	1	-4,22	varied	varied	varied	0	0.9
5	1	-4,22	varied	varied	varied	varied	0.6
6	1	10	-4,8	varied	varied	varied	0.6
7	1	15	-4,8	varied	varied	0	0.6
8	1	18,20	-4,8	varied	varied	0	0.6
9	1	-4,22	0	0	0	0	varied
10	1	-4,22	0	0	0	0	varied
11	1	-4,22	0	0	0	0	varied
12	1	11	-4,8	varied	varied	0	1.2
13	1	16	-4,8	varied	varied	0	1.2
14	1	11,21	-4,8	0	0	0	1.2
15	1	-4,22	0	varied	0	0	0.6
16	1	-4,22	0	varied	0	0	0.9
17	1	-4,22	0	varied	0	0	1.2
18	1	-4,22	4,8	0	0	0	0.9
19	1	10	-4,8	varied	0	0	0.6
20	1	15	-4,8	varied	0	0	0.6
21	1	10	-4,8	varied	0	0	0.9
22	1	16	-4,8	varied	0	0	0.9
23	1	11	-4,8	varied	0	0	1.2
24	1	16	-4,8	varied	0	0	1.2
25	1	18,20	-4,8	0	0	0	0.9

TABLE 2. - Continued

Figure	Config-uration	ALPHA	BETA	DCL	DCR	DS	MACH
26	2	-4,22	0	varied	varied	0	0.6
27	2	-4,22	0	varied	varied	5	0.6
28	2	-4,22	0	varied	varied	5	0.9
29	2	-4,22	0	varied	varied	-5	0.6
30	2	-4,22	0	varied	varied	-5	0.9
31	2	-4,22	0	varied	varied	10	0.6
32	2	-4,22	0	varied	varied	10	0.9
33	2	-4,22	0	0	0	varied	0.6
34	2	-4,22	0	0	0	varied	0.9
35	2	10	-6,4	varied	varied	varied	0.6
36	2	15	-6,4	varied	varied	10	0.6
37	2	10,15	-6,4	varied	varied	10	0.6
38	2	11	-6,4	varied	varied	10	0.9
39	2	16	-6,4	varied	varied	10	0.9
40	2	11,16	-6,4	varied	varied	10	0.9
41	3	-4,22	0	varied	varied	10	0.9
42	3	-4,22	0	varied	varied	10	0.6
43	3	-4,22	0	varied	varied	-5	0.9
44	3	-4,22	0	varied	varied	-5	0.6
45	3	-4,22	0	varied	varied	5	0.9
46	3	-4,22	0	varied	varied	5	0.6
47	3	-4,22	0	varied	varied	0	0.6
48	3	-4,22	0	0	0	varied	0.9
49	3	-4,22	0	0	0	varied	0.9
50	4	-4,22	0	varied	varied	0	0.6

TABLE 2. - Continued

Figure	Config-uration	ALPHA	BETA	DCL	DCR	DS	MACH
51	4	10	-6,4	varied	varied	0	0.6
52	4	11	-6,4	varied	varied	0	0.9
53	4	15	-6,4	varied	varied	0	0.6
54	4	16	-6,4	varied	varied	0	0.9
55	5	-1,22	0	varied	varied	0	0.6
56	5	-1,22	0	varied	varied	0	0.9
57	5	-1,22	0	varied	varied	0	1.2
58	5	-1,22	0	0	0	0	varied
59	5	10	-6,4	varied	varied	0	0.6
60	5	15	-6,4	varied	varied	0	0.6
61	5	10	-6,4	varied	varied	0	0.9
62	5	15	-6,4	varied	varied	0	0.9
63	6	-1,22	0	varied	varied	0	1.2
64	6	-1,22	0	varied	varied	0	0.9
65	6	-1,22	0	varied	varied	0	0.6
66	6	-1,22	0	0	0	0	varied
67	6	11	-6,4	varied	varied	0	0.9
68	6	10	-6,4	varied	varied	0	0.6
69	6	16	-6,4	varied	varied	0	0.9
70	6	15	-6,4	varied	varied	0	0.6
71	7	-1,22	0	varied	varied	0	0.6
72	7	-1,22	0	varied	varied	0	0.9
73	8	-1,22	0	varied	varied	0	0.6
74	8	-1,22	0	varied	varied	0	0.9
75	8	-1,22	0	varied	varied	0	1.2

TABLE 2. - Concluded

Figure	Config-uration	ALPHA	BETA	DCL	DCR	DS	MACH
76	8	-1,22	0	0	0	0	varied
77	8	10	-6,4	varied	varied	0	0.6
78	8	15	-6,4	varied	varied	0	0.6
79	8	10	-6,4	varied	varied	0	0.9
80	8	16	-6,4	varied	varied	0	0.9
81	8	11	-6,4	varied	varied	0	1.2
82	8	16	-6,4	varied	varied	0	1.2
83	9	-1,22	0	varied	varied	0	1.2
84	9	-1,22	0	varied	varied	0	0.9
85	9	-1,22	0	varied	varied	0	0.6
86	9	-1,22	0	0	0	0	varied
87	9	11	-6,4	varied	varied	0	0.9
88	9	16	-6,4	varied	varied	0	0.9
89	9	10	-6,4	varied	varied	0	0.6
90	9	15	-6,4	varied	varied	0	0.6
91	10	-4,22	0	0	0		varied
92	11	-4,22	0				varied

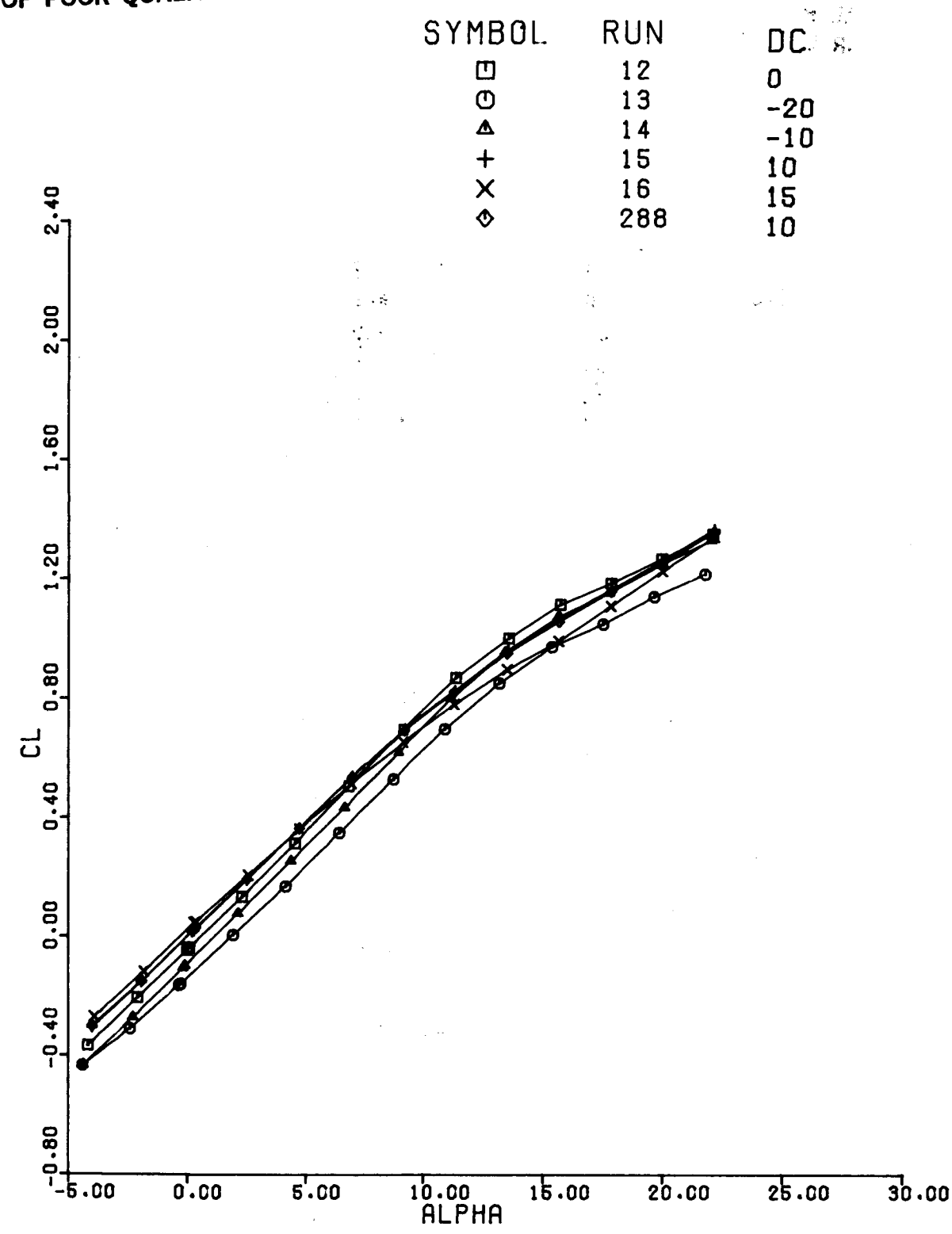

Figure 1(a). CL vs ALPHA
Configuration 1, MACH = 0.6, BETA = 0

SYMBOL	RUN	DC
□	12	0
○	13	-20
△	14	-10
+	15	10
×	16	15
◇	288	10

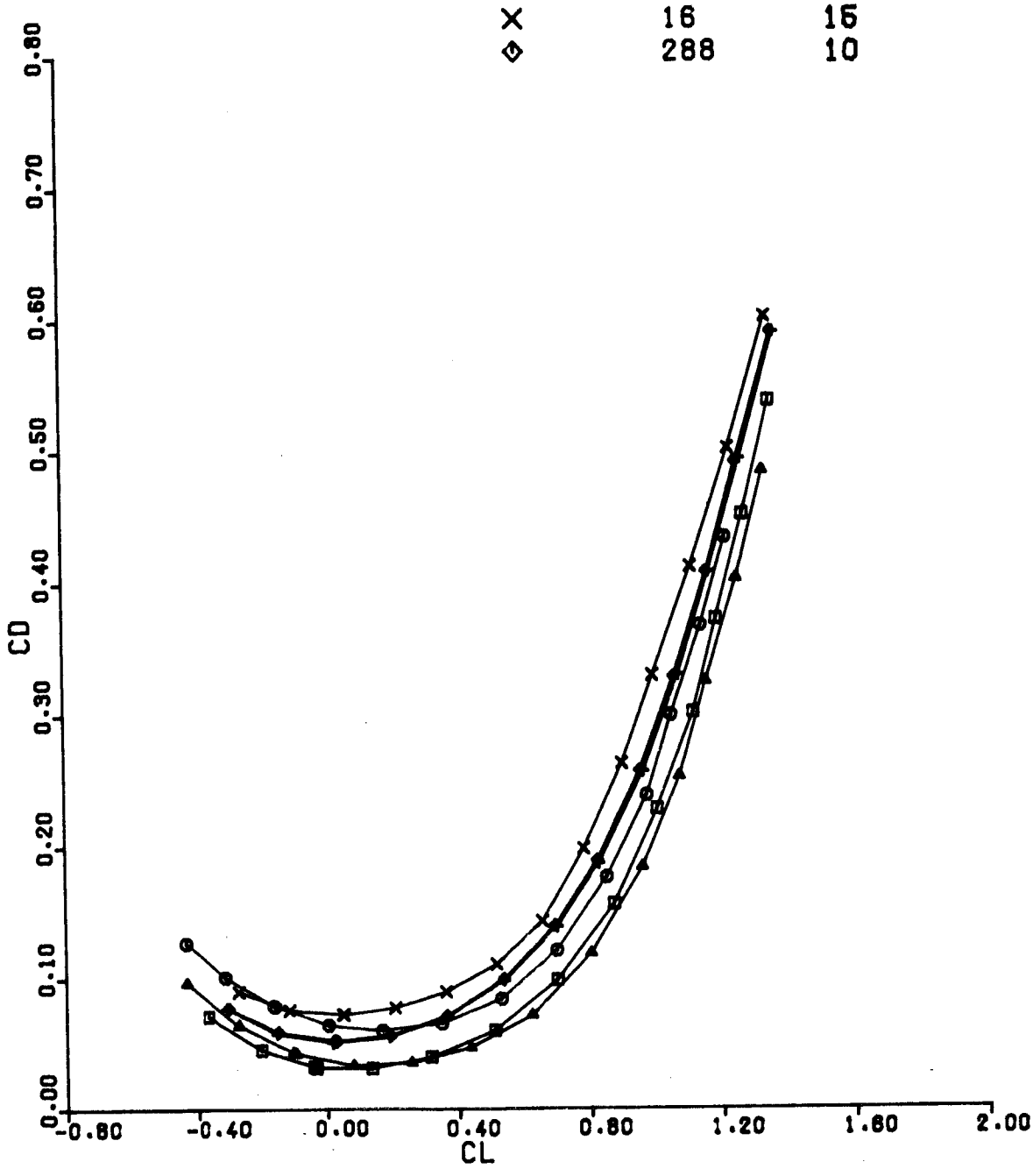

Figure 1(b). CD vs CL
Configuration 1, MACH = 0.6, BETA = 0

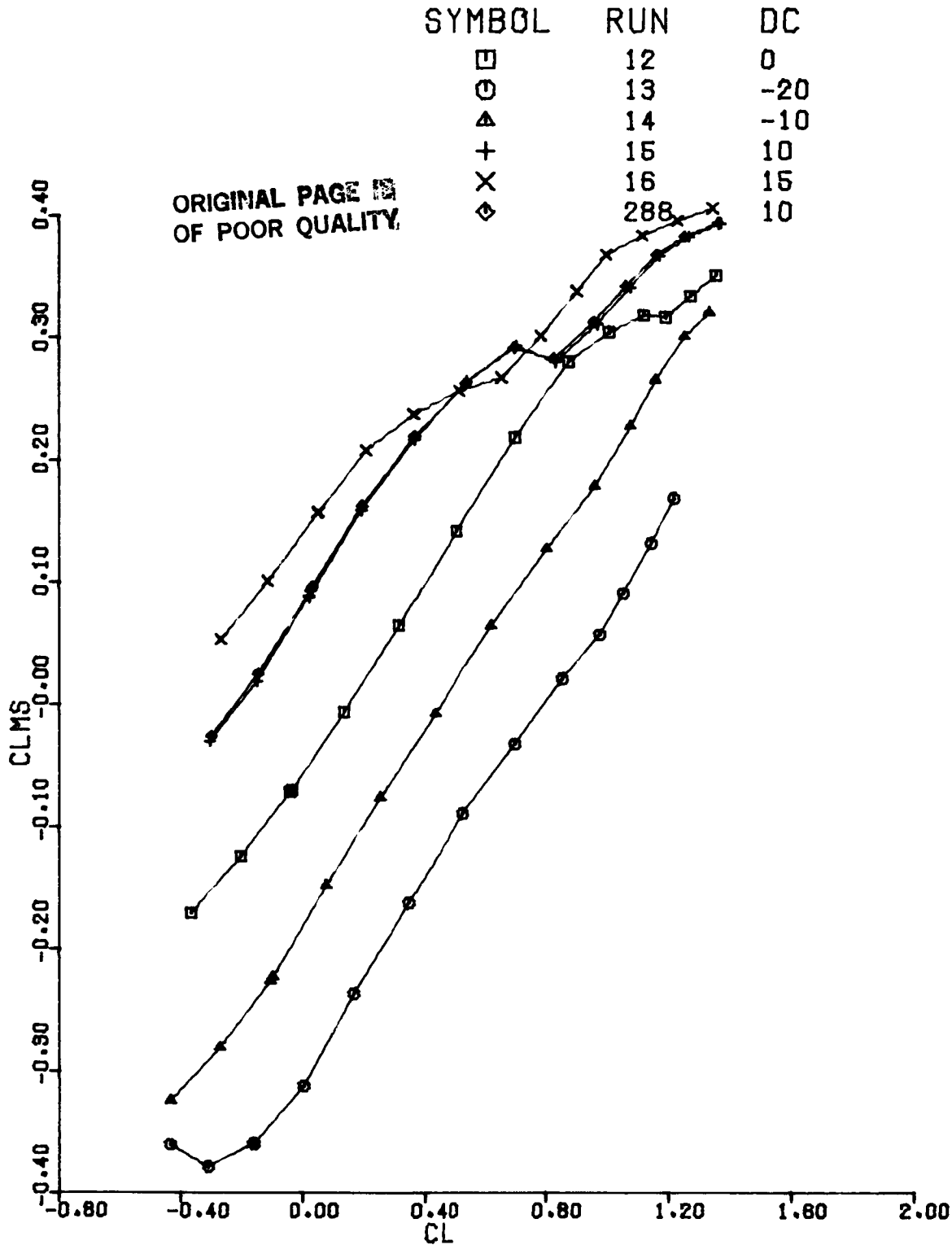

Figure 1(c). CLMS vs CL
Configuration 1, MACH = 0.6, BETA = 0

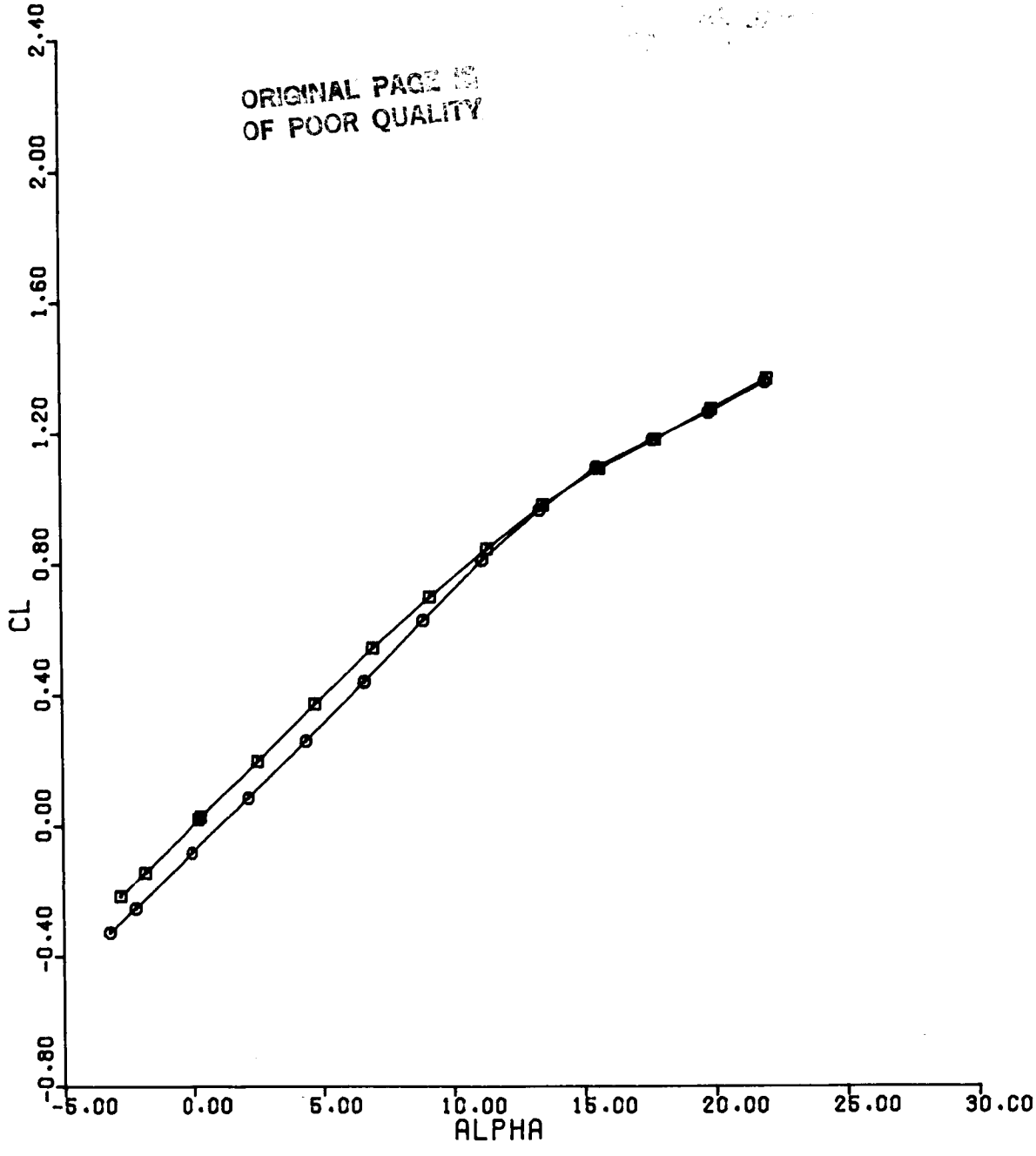

Figure 2(a). CL vs ALPHA
Configuration 1, MACH = 0.6, BETA = 4

SYMBOL	RUN	DC α
⊡	26	-10
⊙	27	10

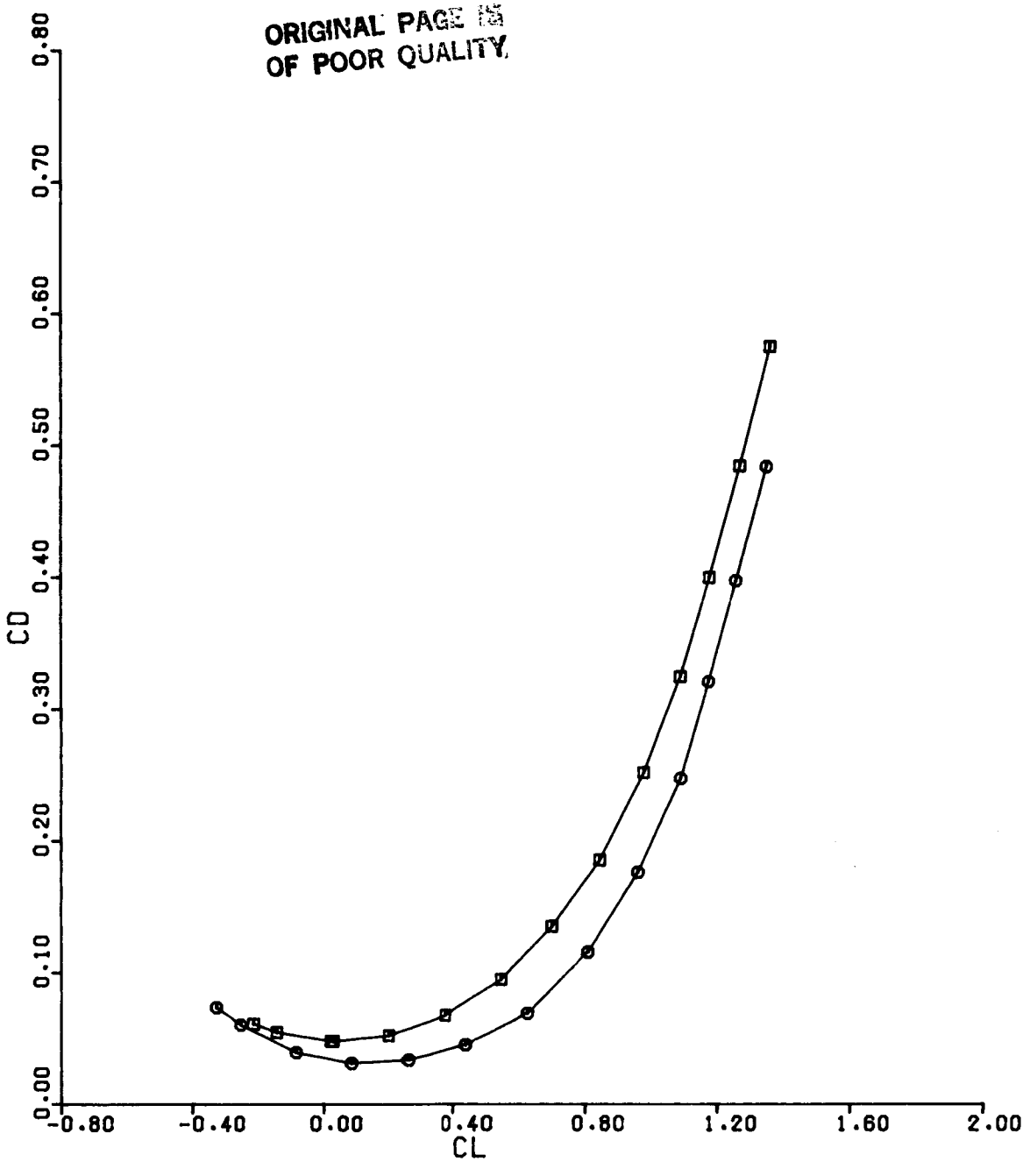

Figure 2(b). CD vs CL
Configuration 1, MACH = 0.6, BETA = 4

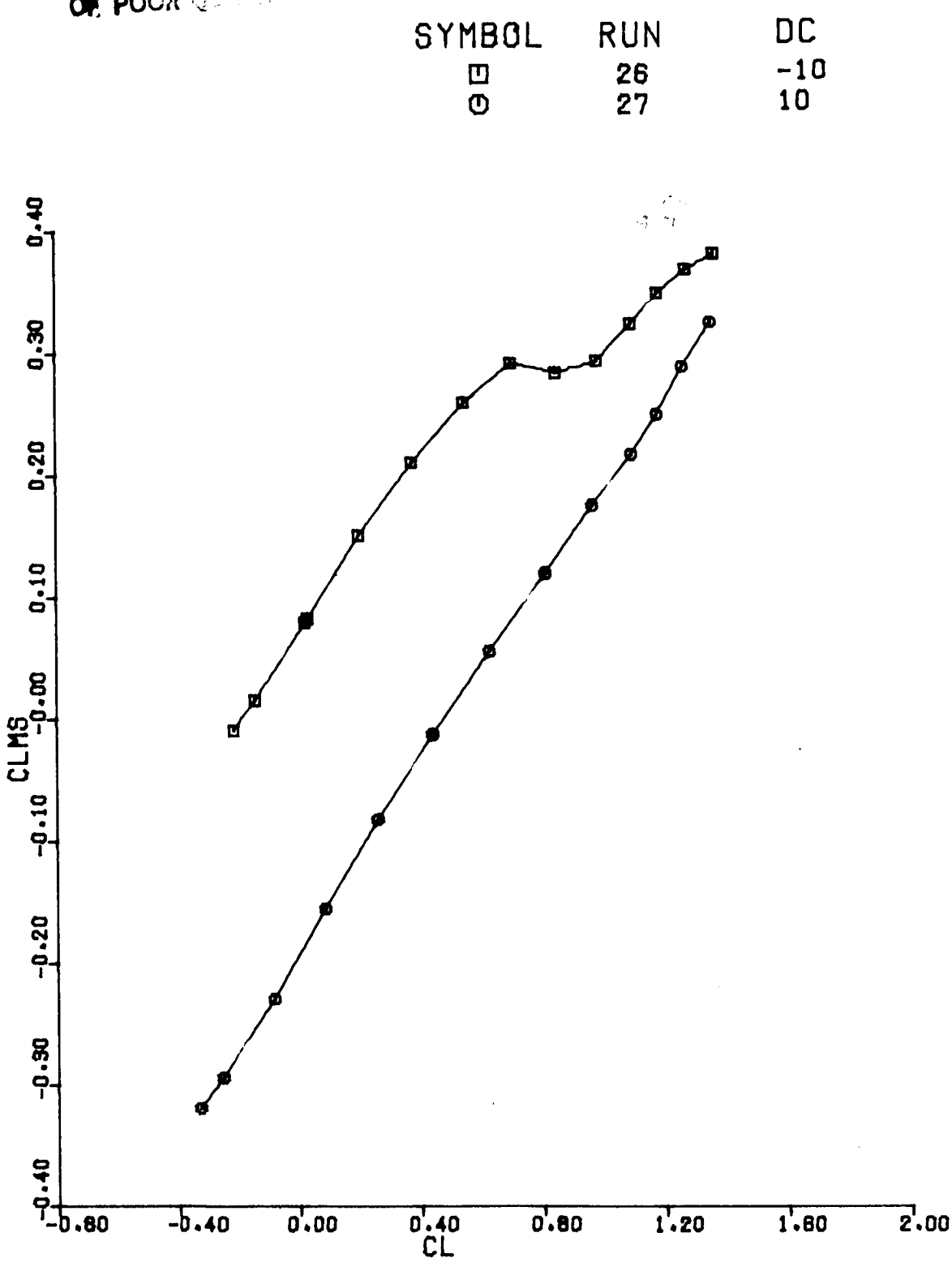

Figure 2(c). CLMS vs CL
Configuration 1, MACH = 0.6, BETA = 4

SYMBOL	RUN	DC
□	24	-10
○	25	10

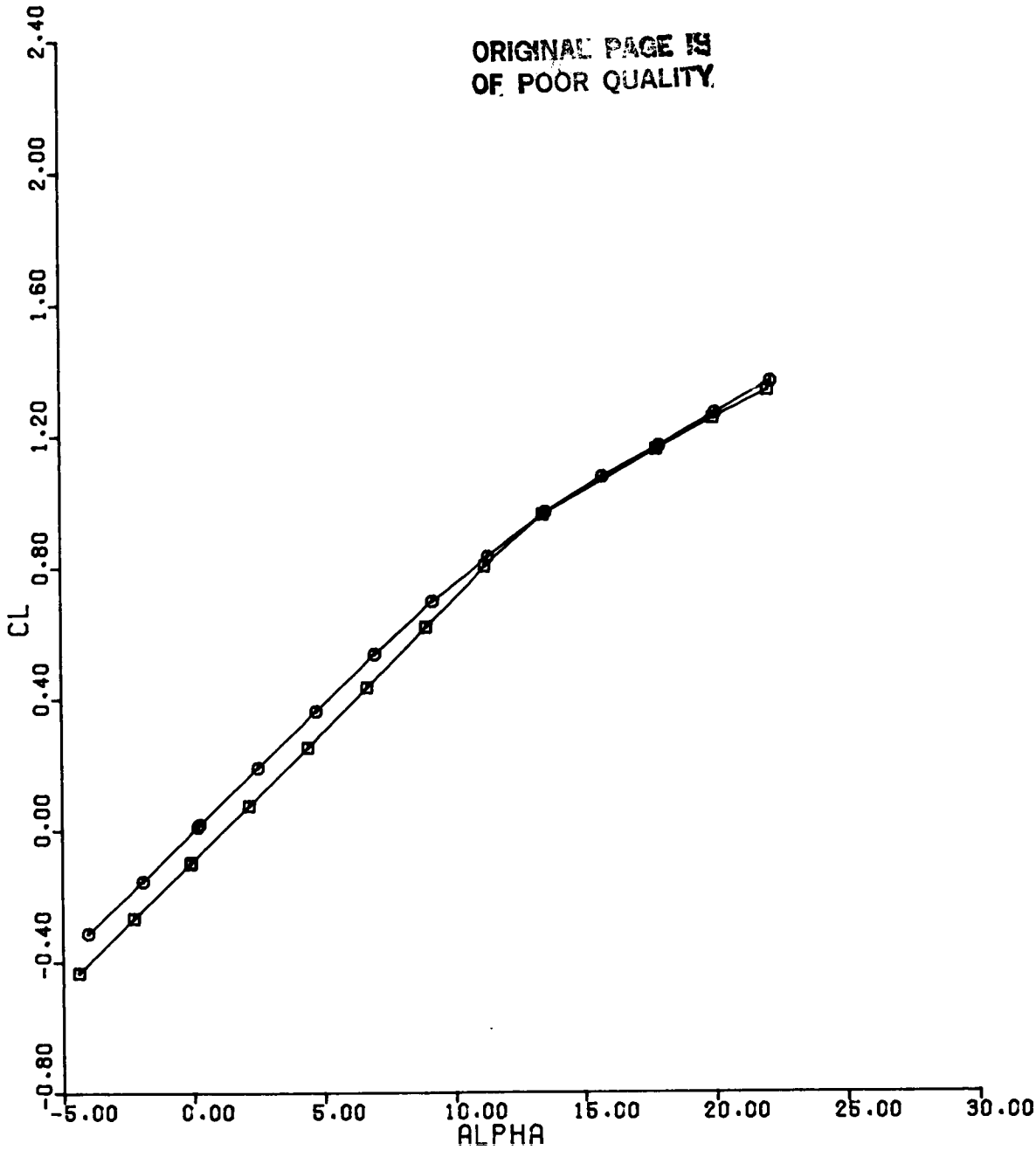

Figure 3(a). CL vs ALPHA
Configuration 1, MACH = 0.6, BETA = 8

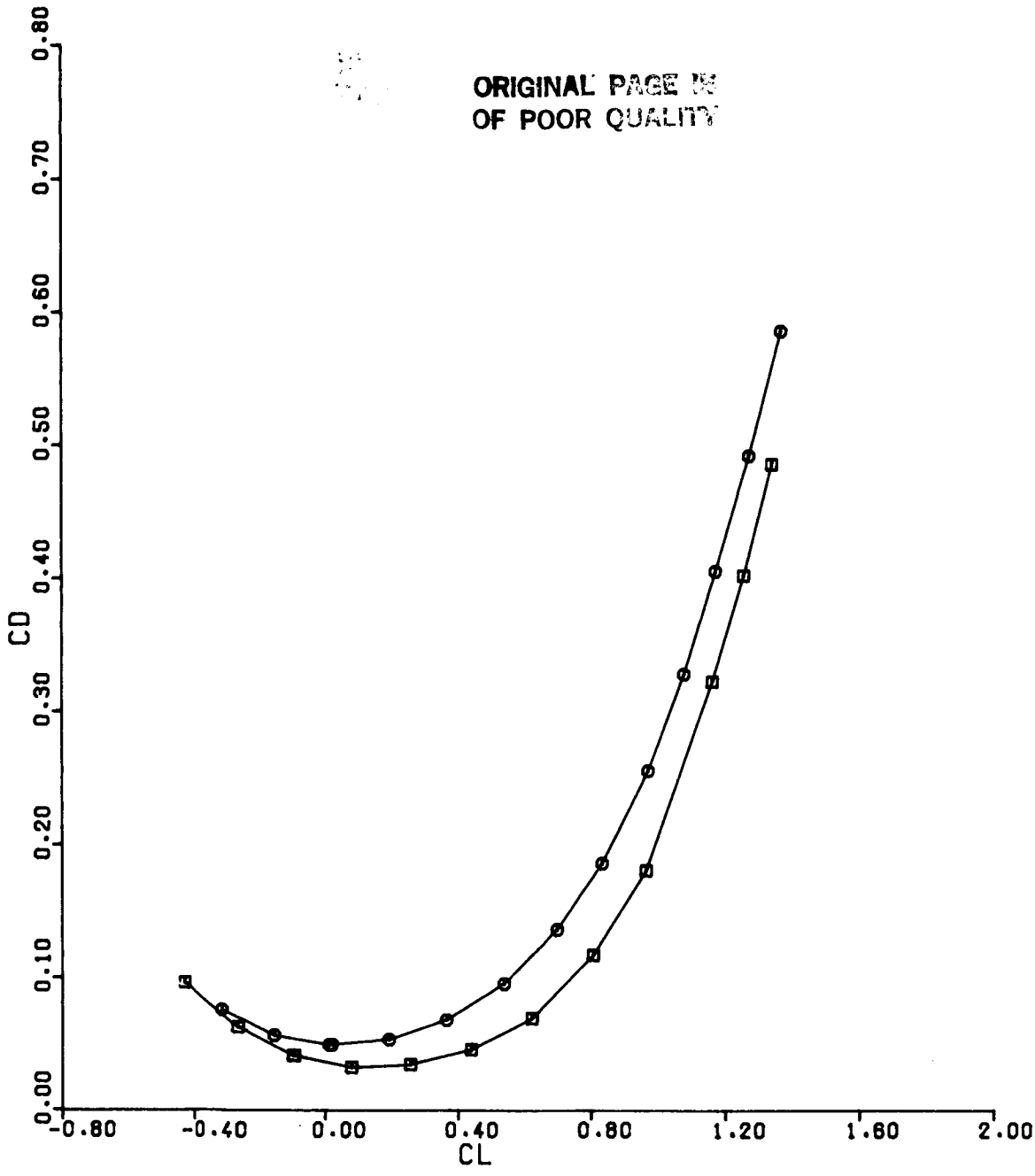

Figure 3(b). CD vs CL
Configuration 1, MACH = 0.6, BETA = 8

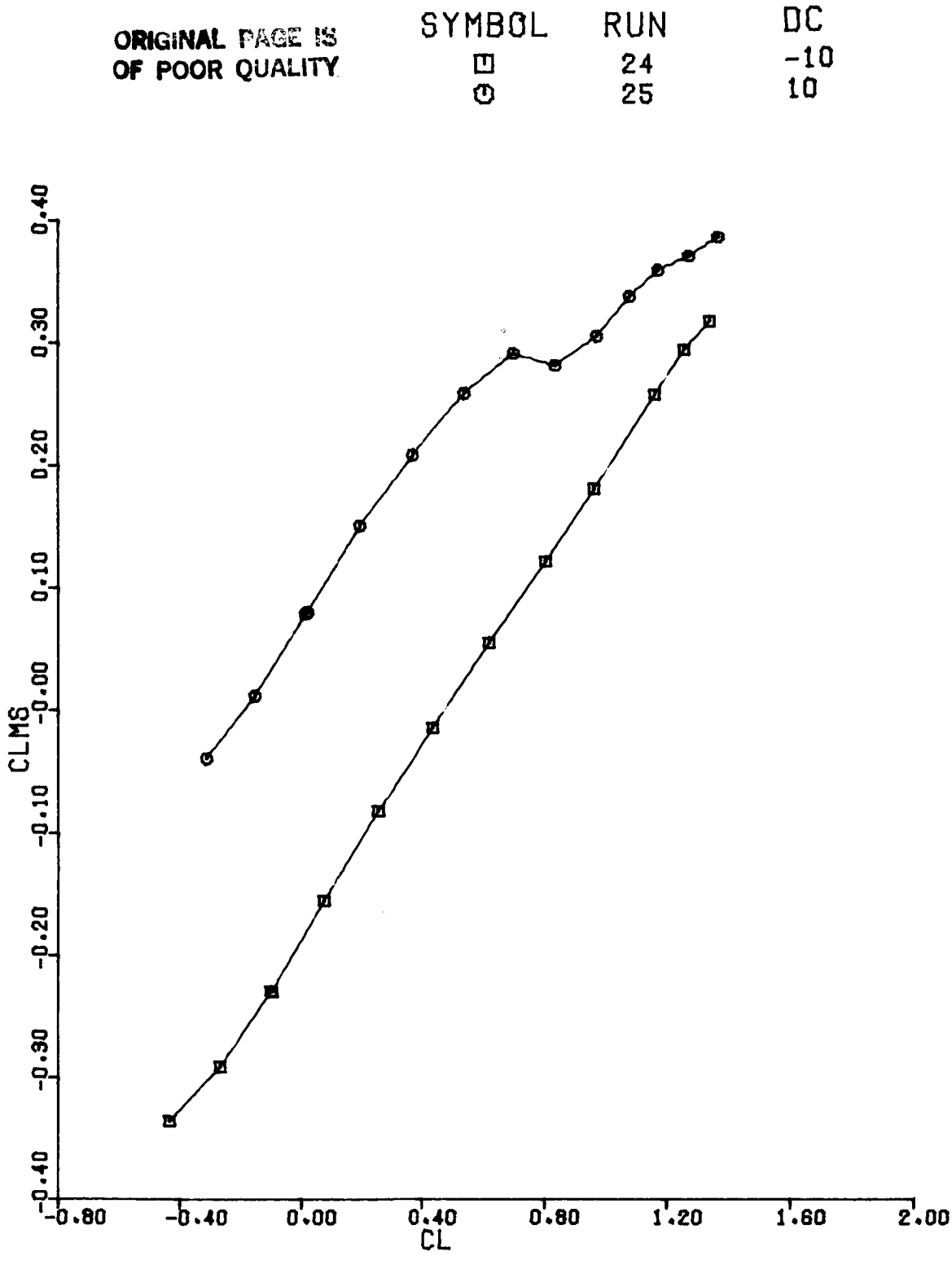

Figure 3(c). CLMS vs CL
Configuration 1, MACH = 0.6, BETA = 8

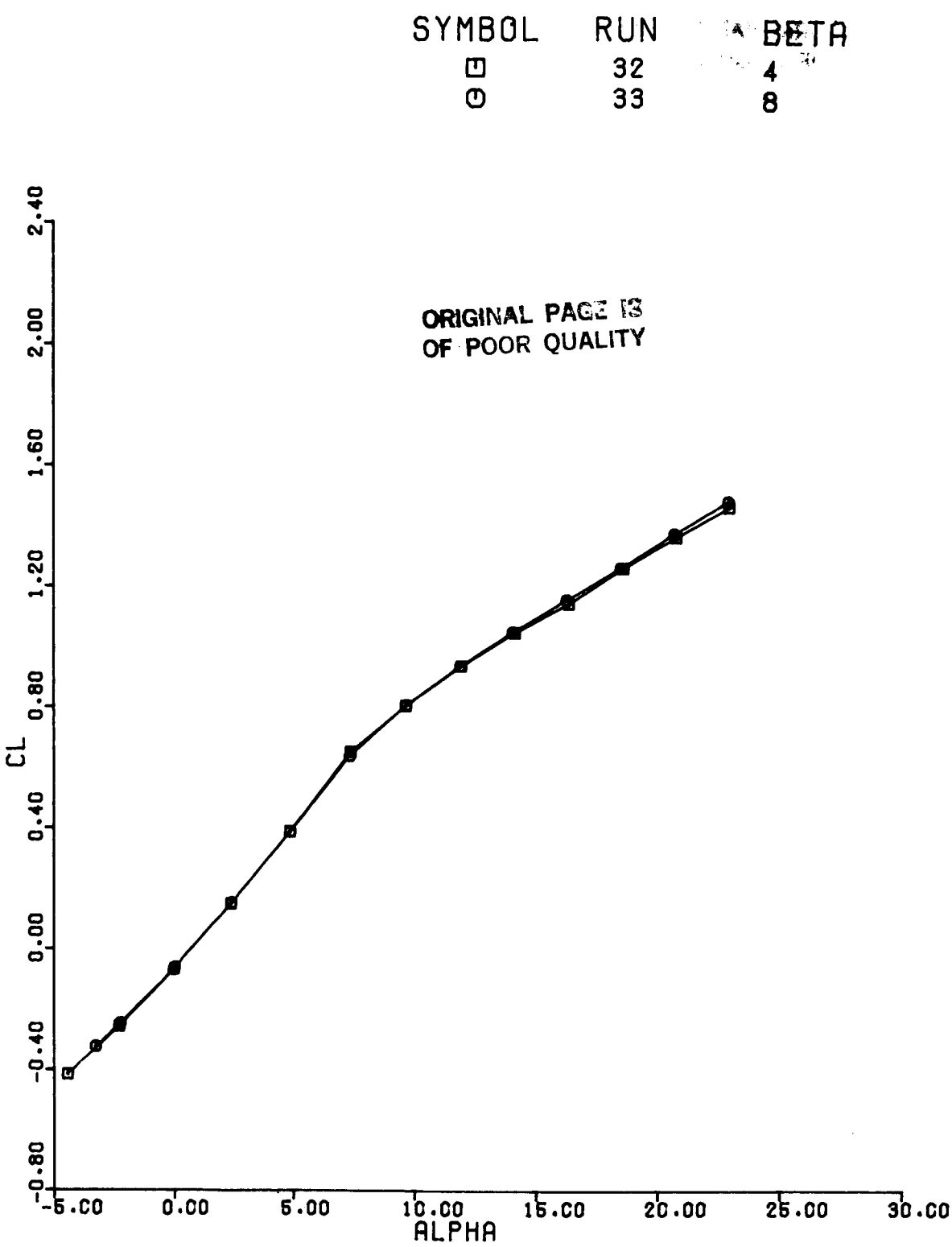

Figure 4(a). CL vs ALPHA
Configuration 1, MACH = 0.9, DC = 0

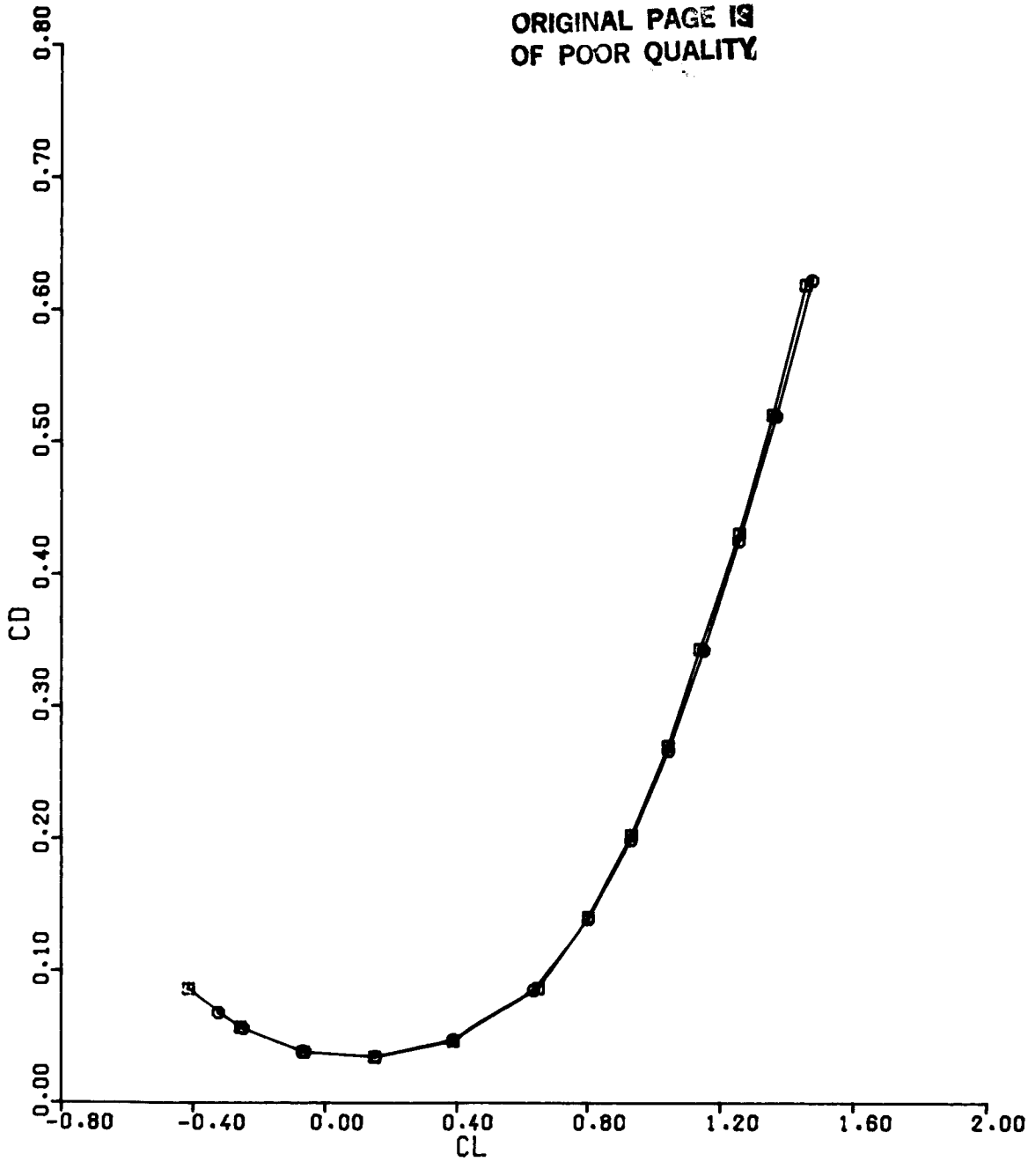

Figure 4(b). CD vs CL
Configuration 1, MACH = 0.9, DC = 0

SYMBOL	RUN	BETA
⊡	32	4
⊙	33	8

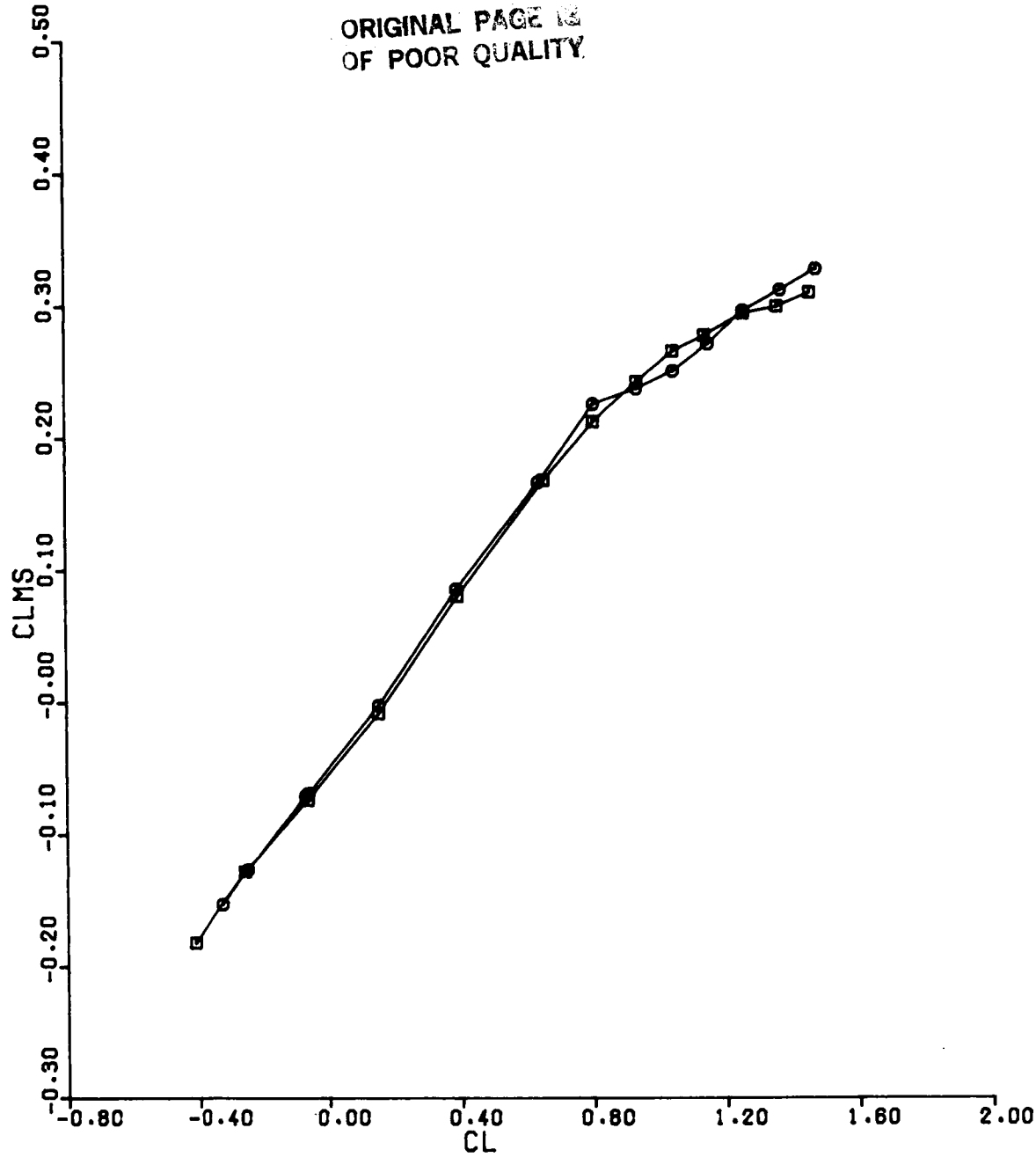

Figure 4(c). CLMS vs CL
Configuration 1, MACH = 0.9, DC = 0

SYMBOL	RUN	DC	BETA
□	24	-10	4
○	25	10	4
△	26	-10	8
+	27	10	8

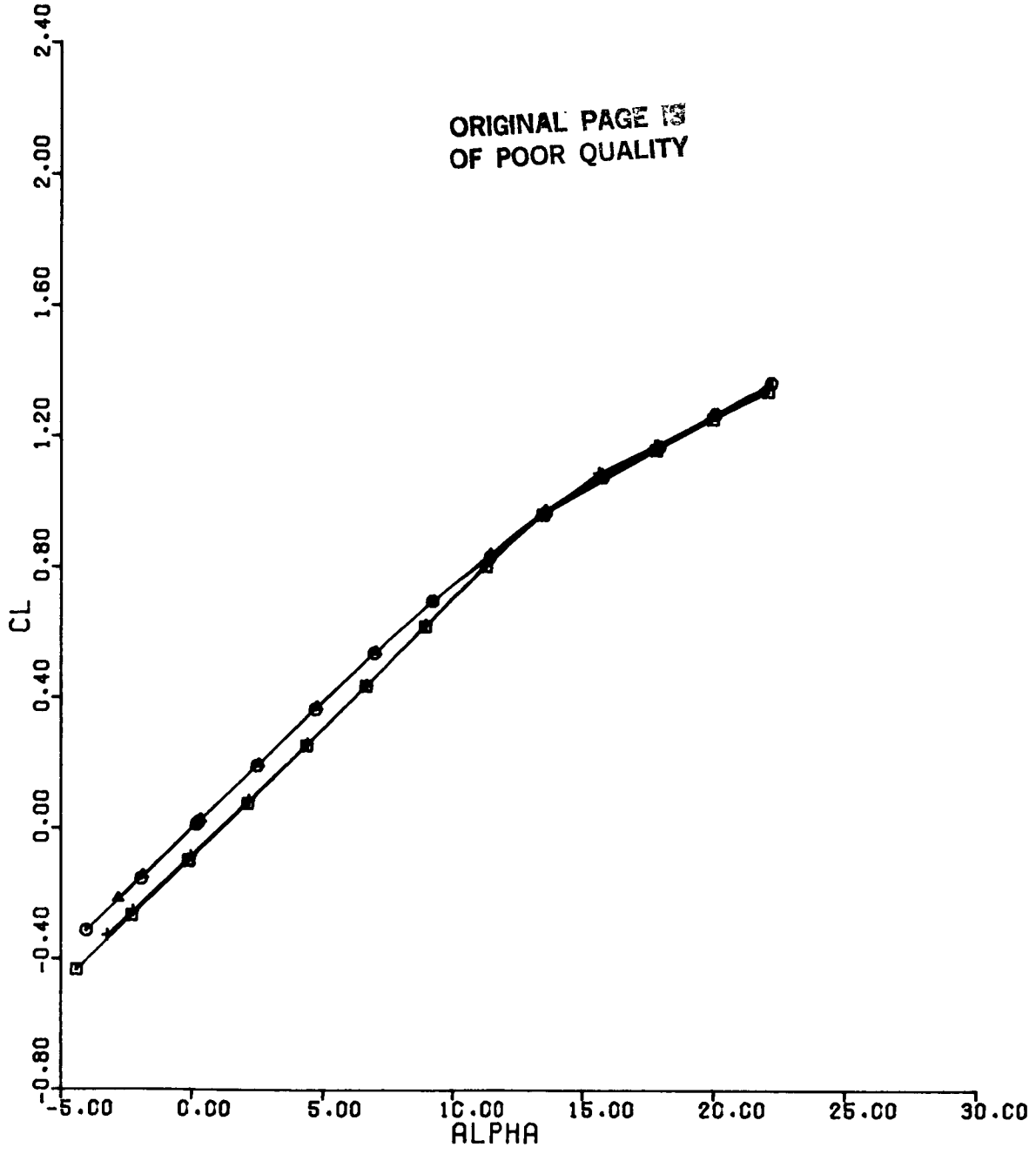

Figure 5(a). CL vs ALPHA
Configuration 1, MACH = 0.6

SYMBOL	RUN	DC	BETA
□	24	-10	4
○	25	10	4
△	26	-10	8
+	27	10	8

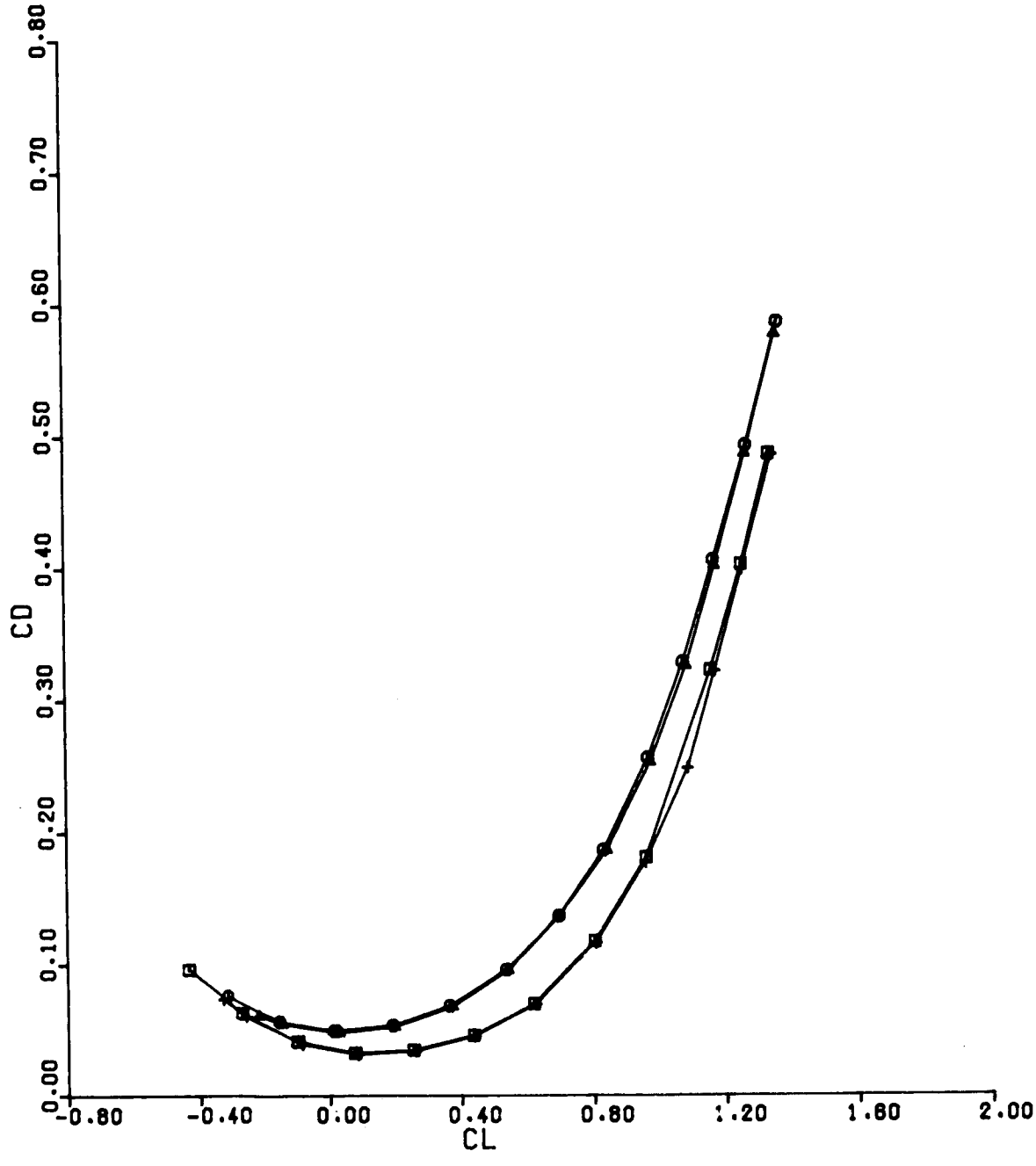

Figure 5(b). CD vs CL
Configuration 1, MACH = 0.6

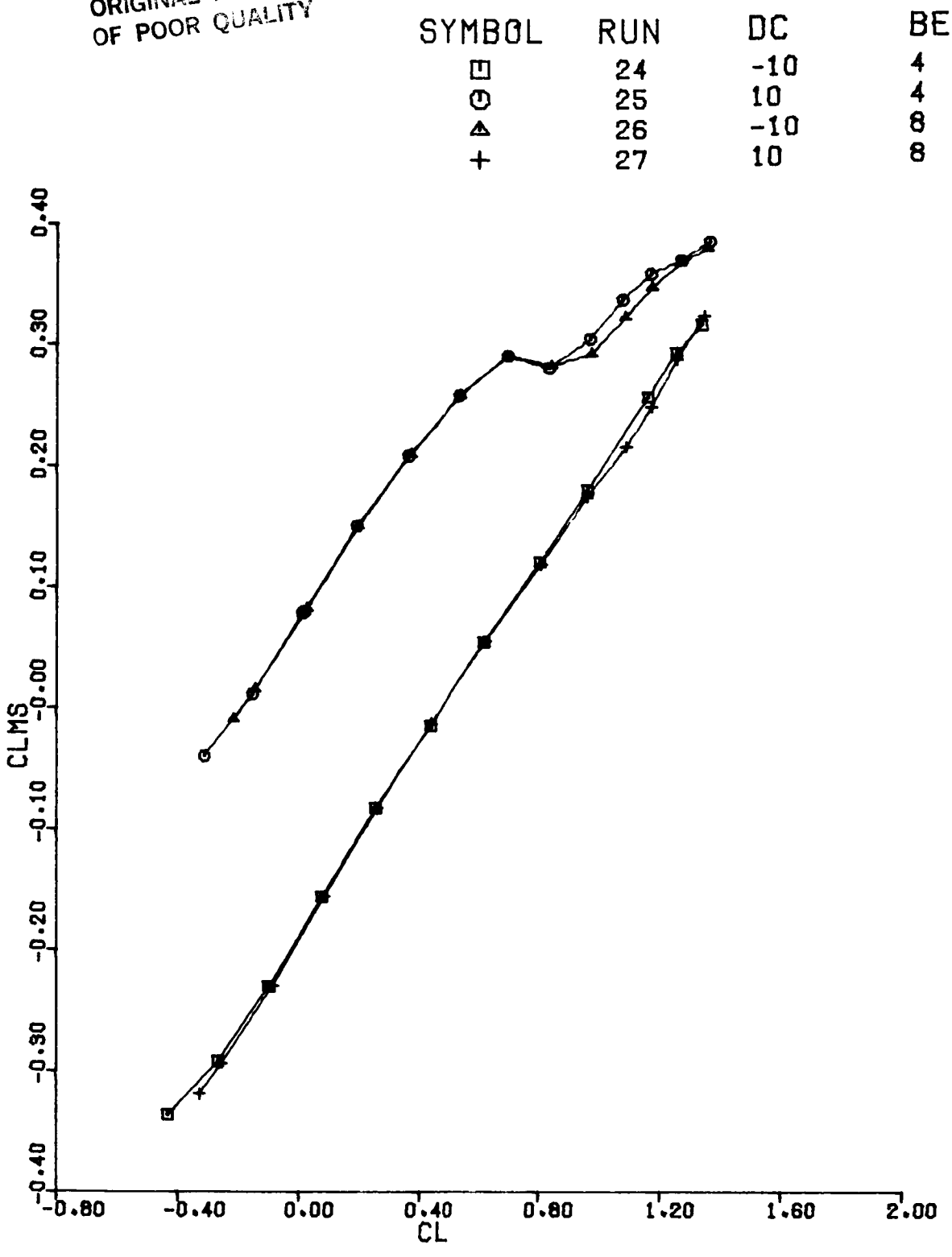

Figure 5(c). CLMS vs CL
Configuration 1, MACH = 0.6

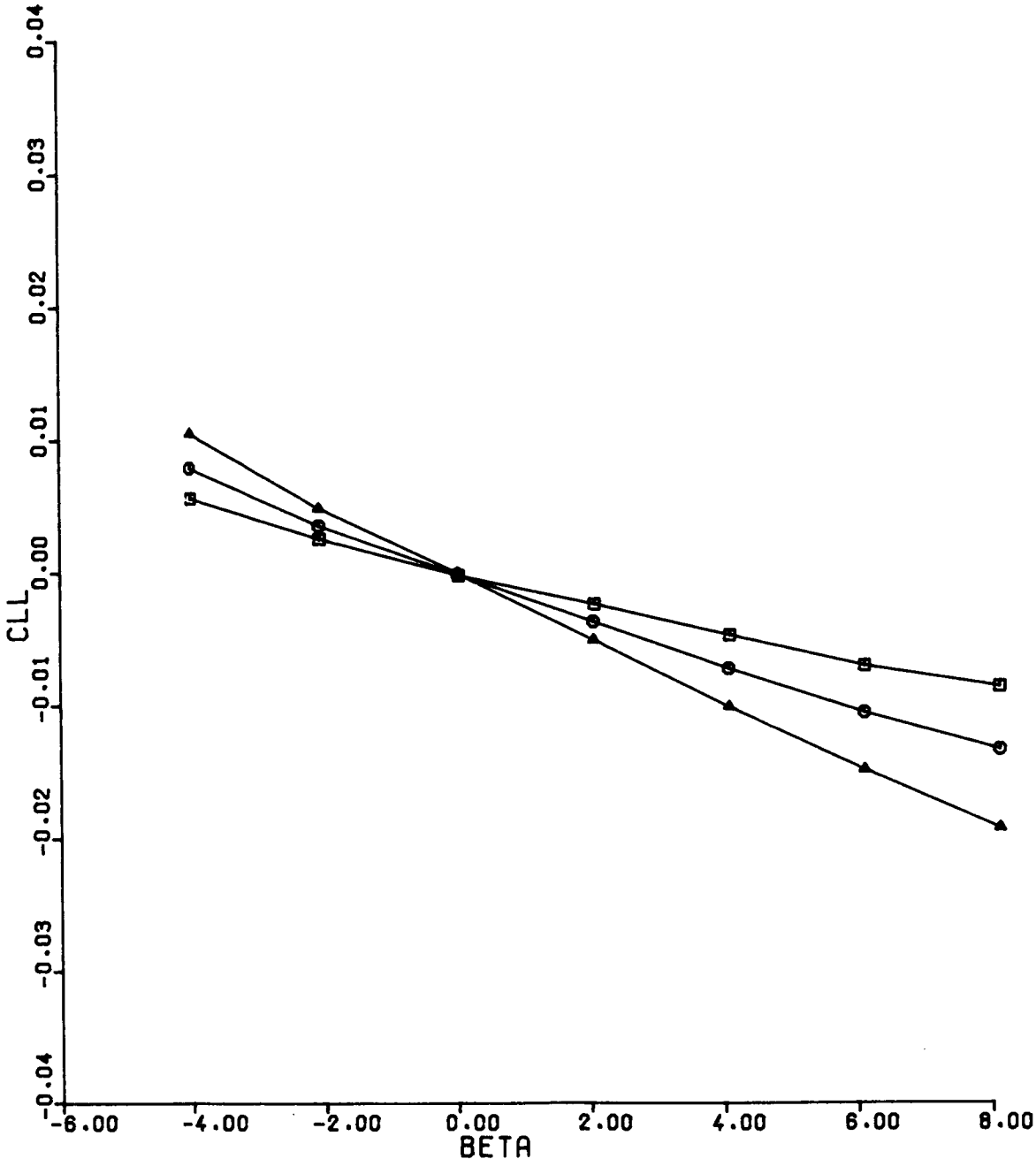

Figure 6(a). CLL vs BETA
Configuration 1, MACH = 0.6, ALPHA = 10

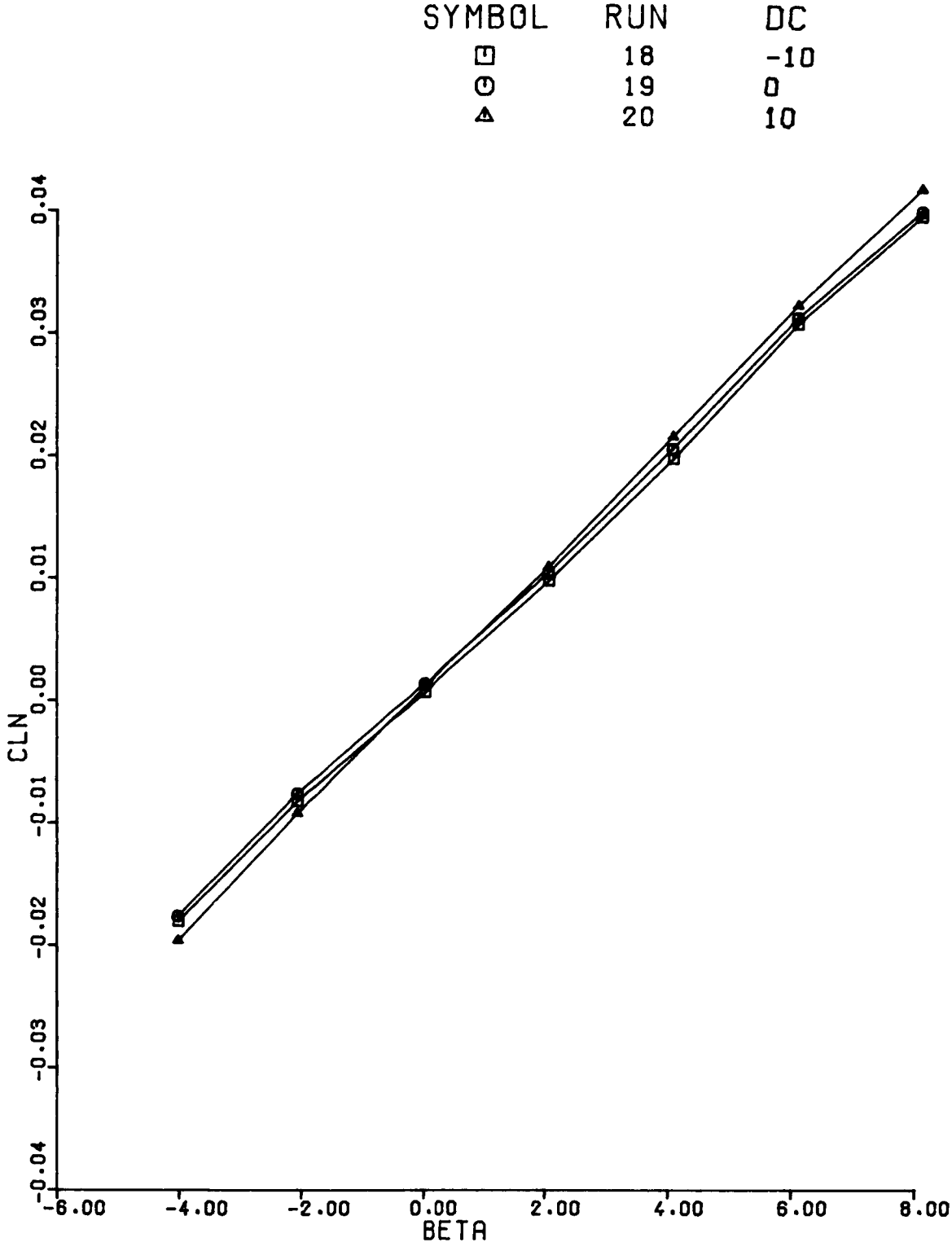

Figure 6(b). CLN vs BETA
Configuration 1, MACH = 0.6, ALPHA = 10

SYMBOL	RUN	DC
□	18	-10
○	19	0
△	20	10

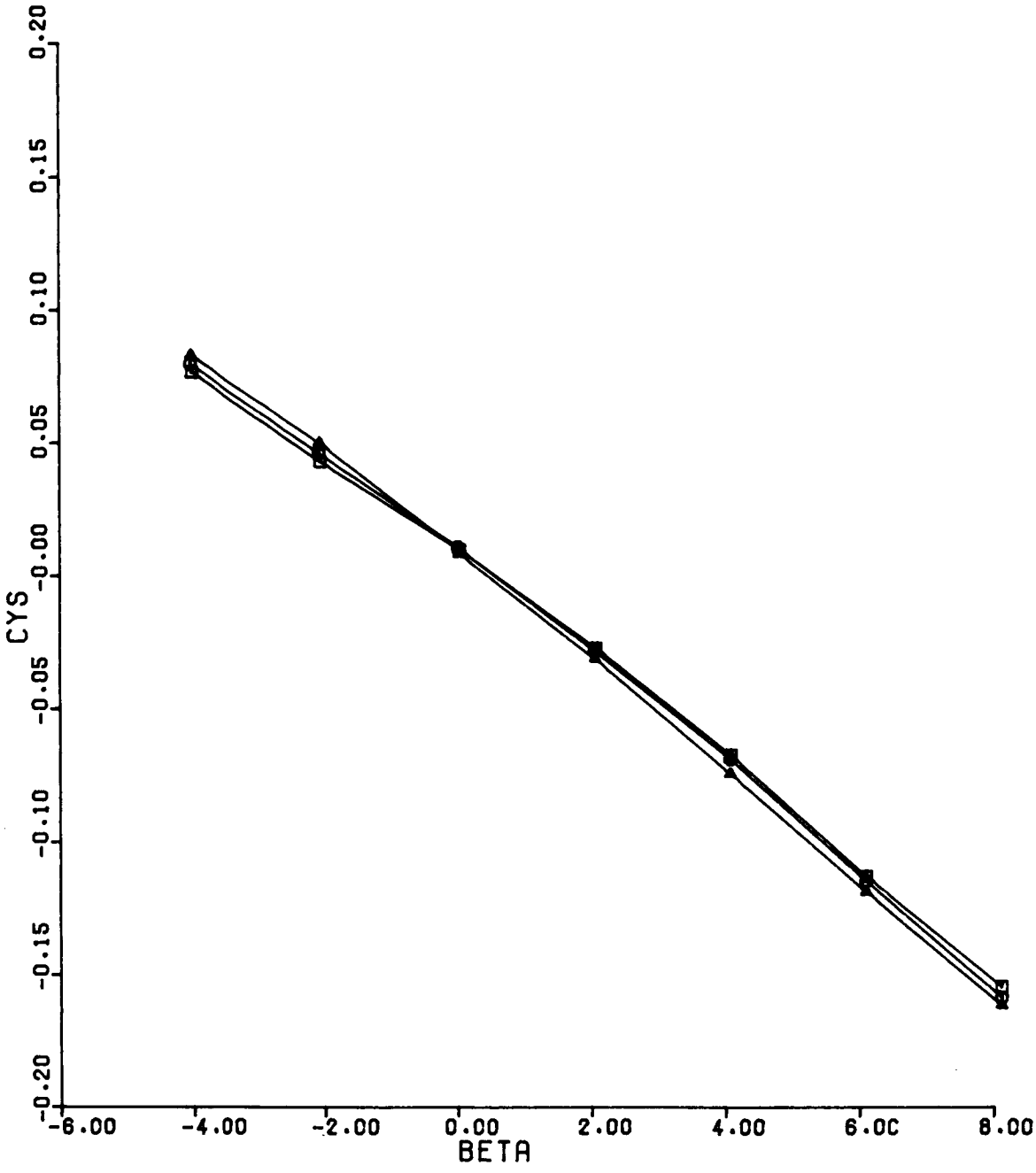

Figure 6(c). CYS vs BETA
Configuration 1, MACH = 0.6, ALPHA = 10

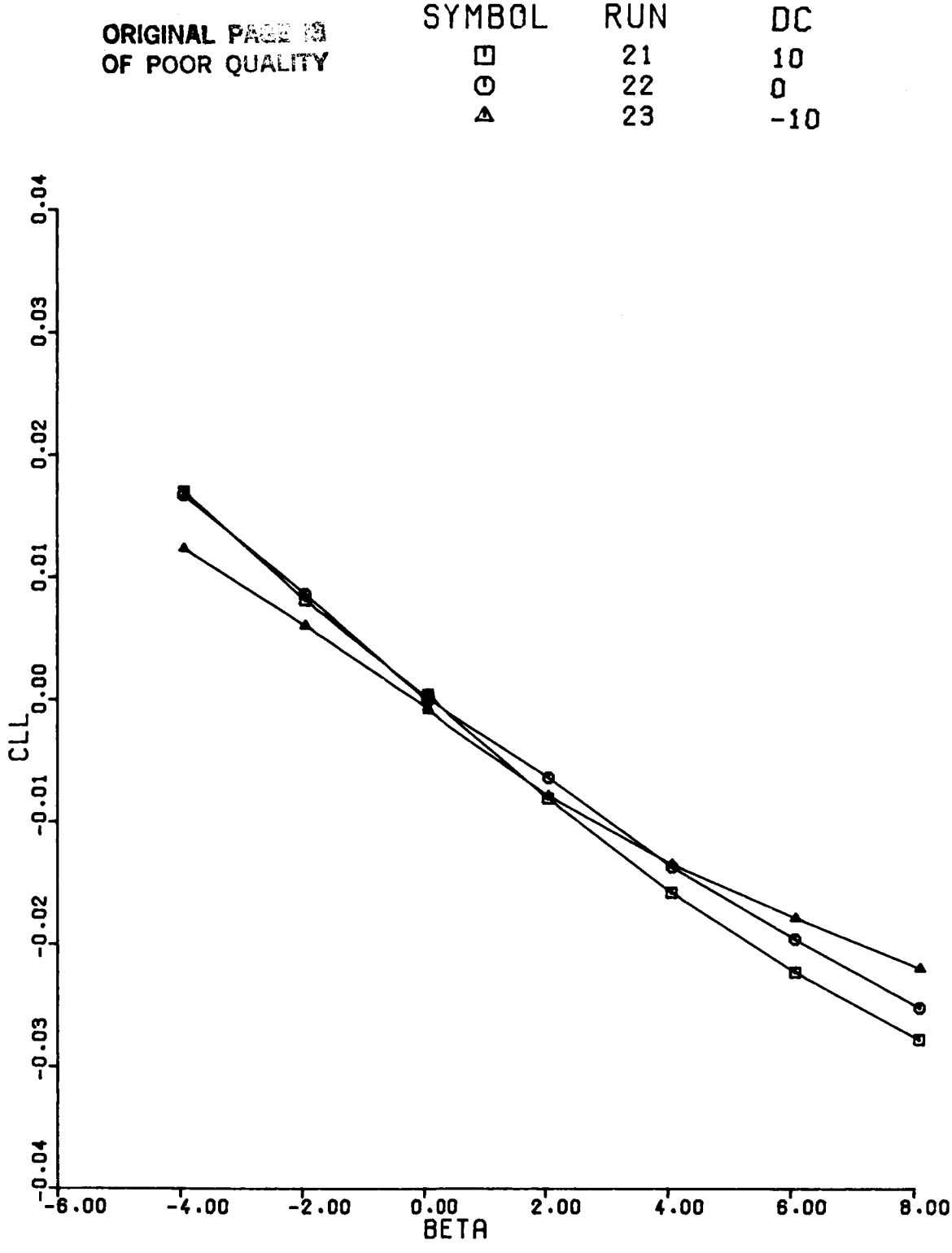

Figure 7(a). CLL vs BETA
Configuration 1, MACH = 0.6, ALPHA = 15

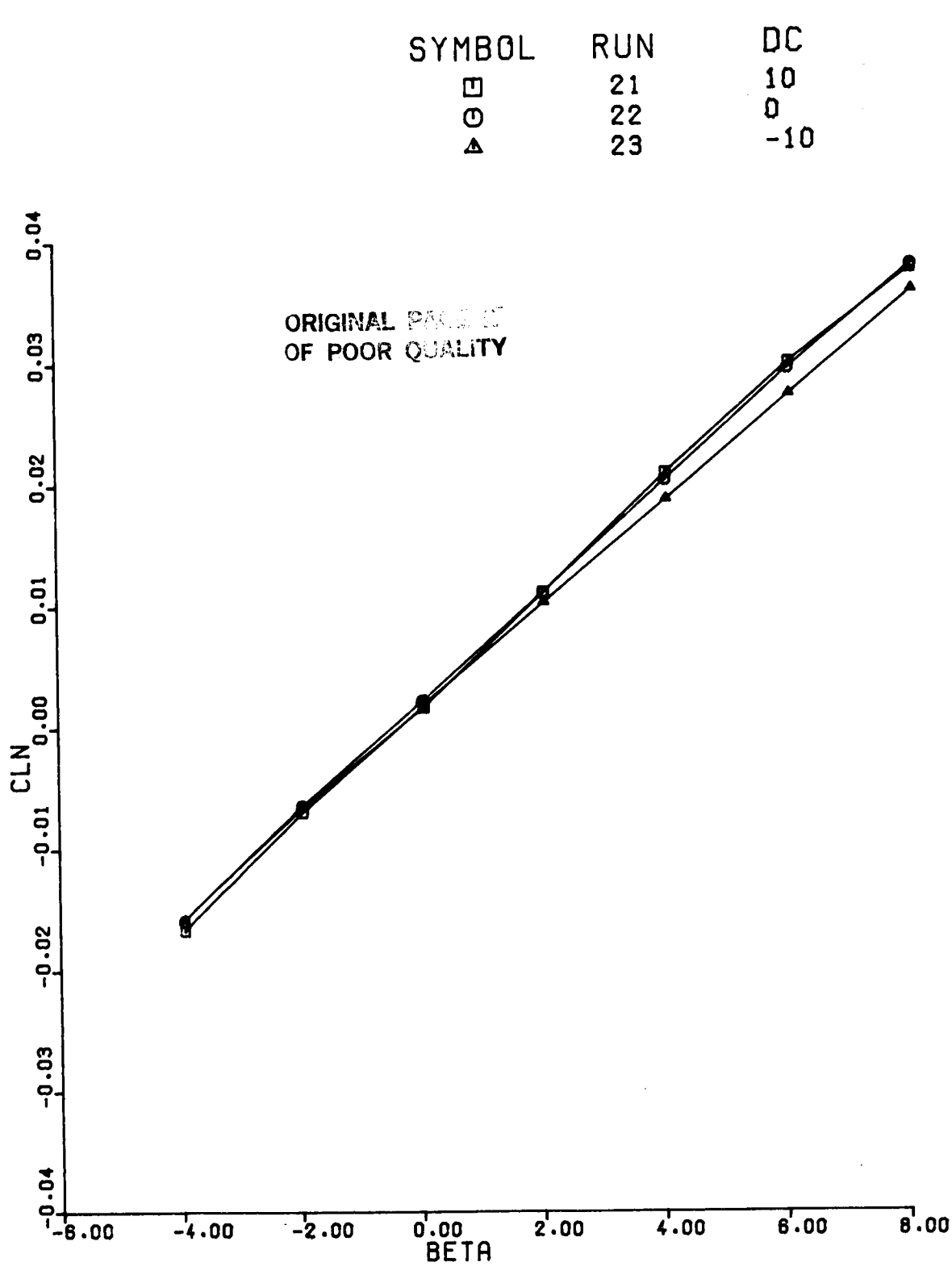

Figure 7(b). CLN vs BETA
Configuration 1, MACH = 0.6, ALPHA = 15

SYMBOL	RUN	DC
□	21	10
○	22	0
△	23	-10

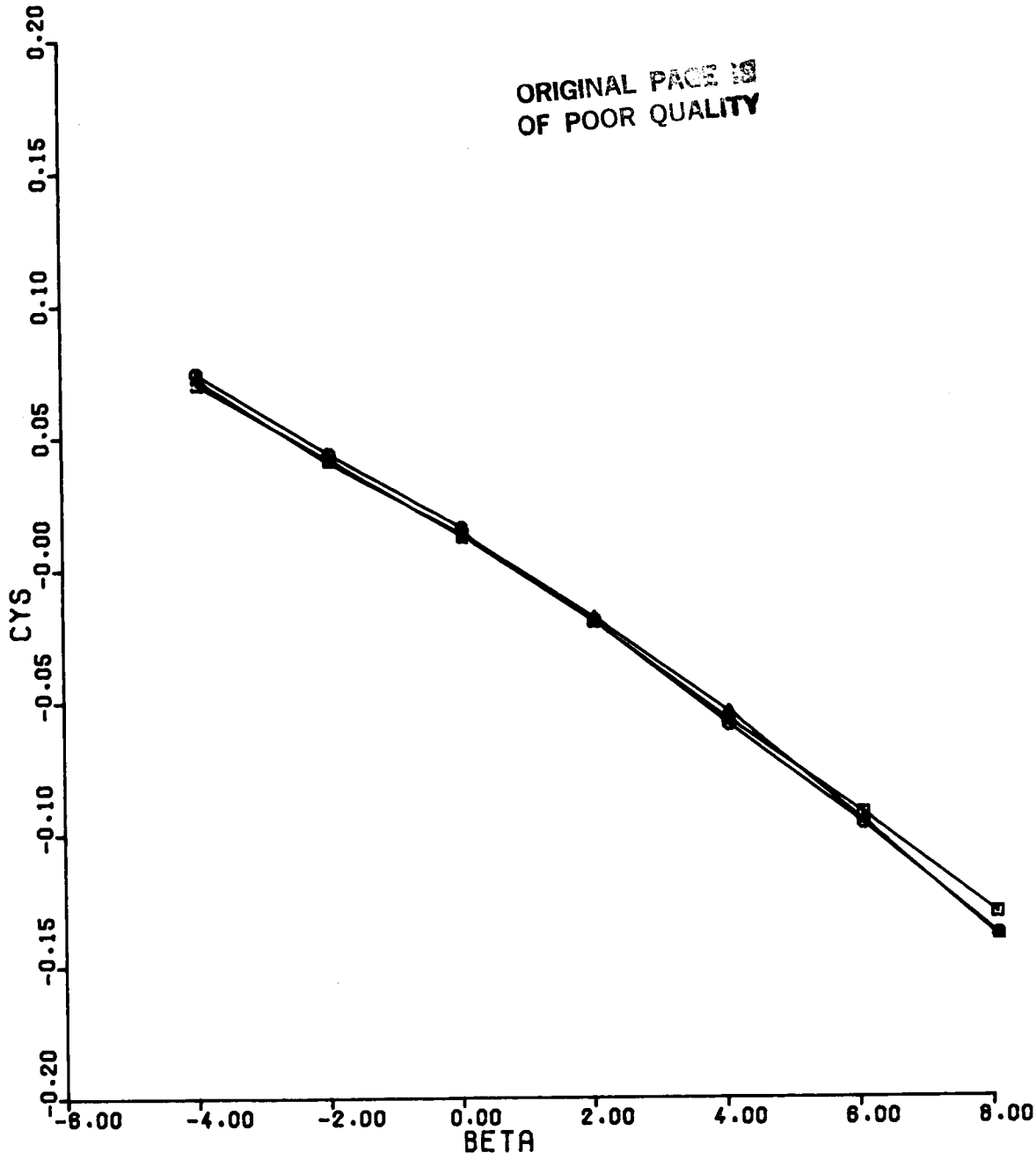

Figure 7(c). CYS vs BETA
Configuration 1, MACH = 0.6, DC = 0

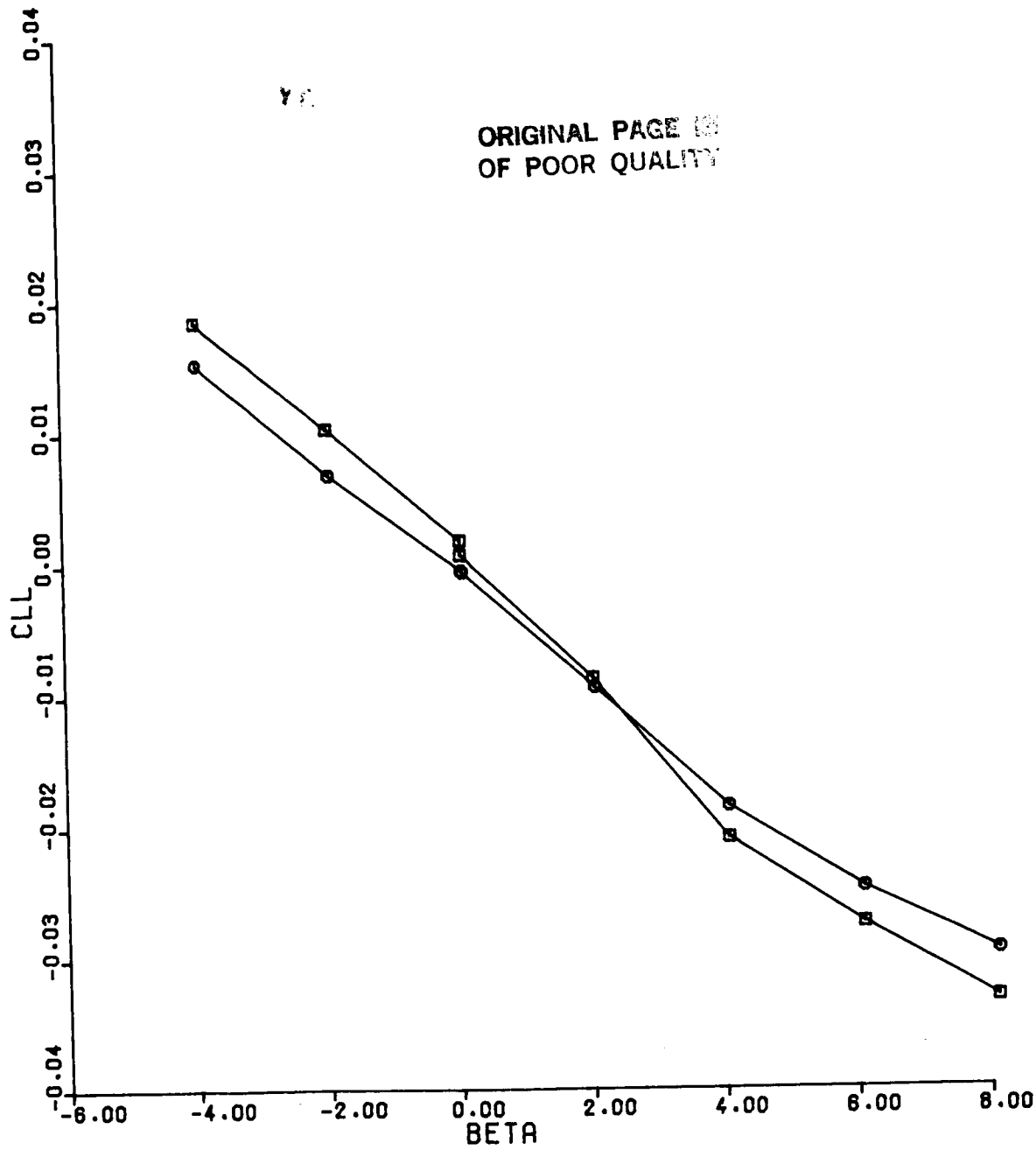

Figure 8(a). CLL vs BETA
Configuration 1, MACH = 0.6, DC = 0

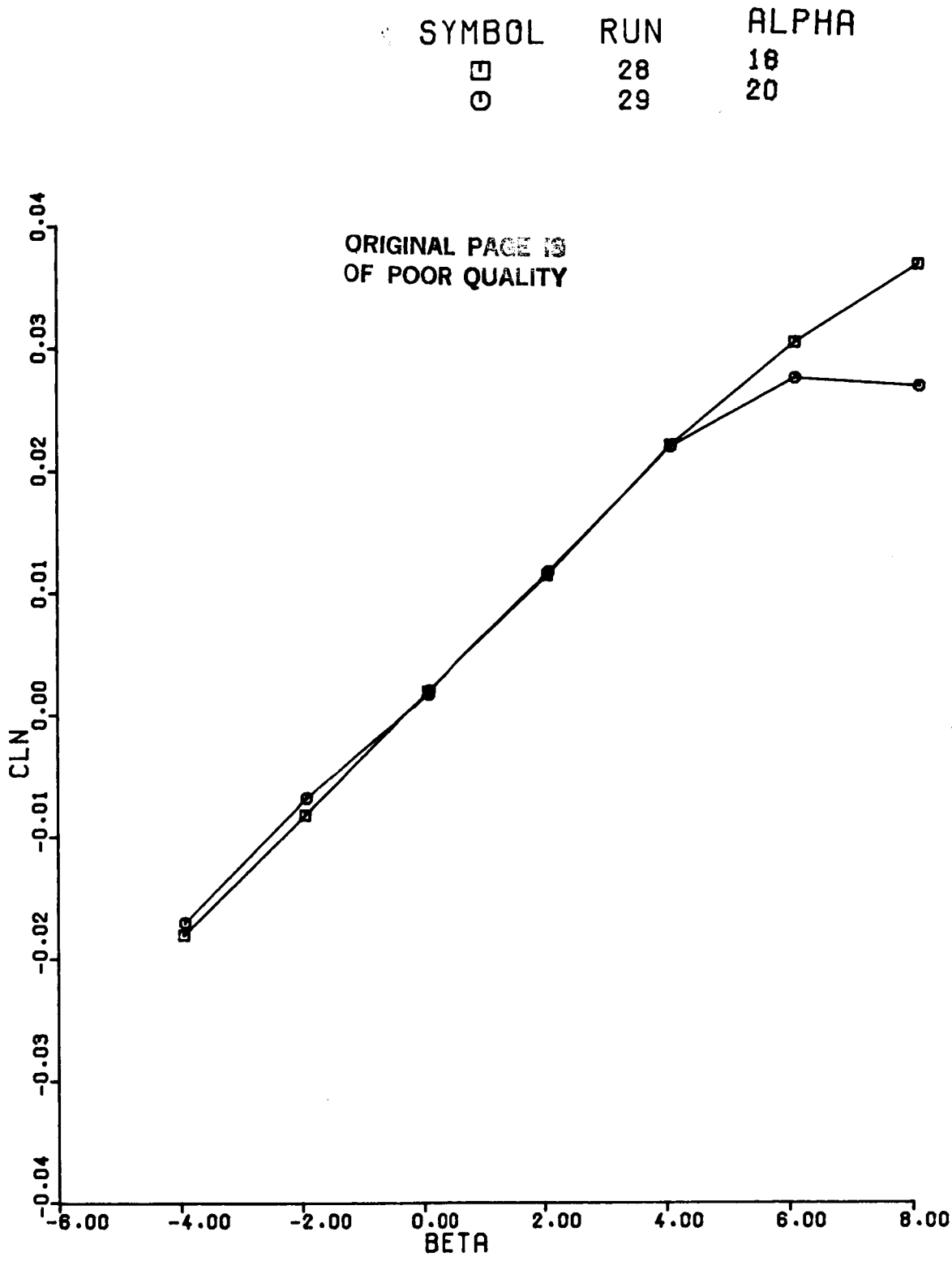

Figure 8(b). CLN vs BETA
Configuration 1, MACH = 0.6, DC = 0

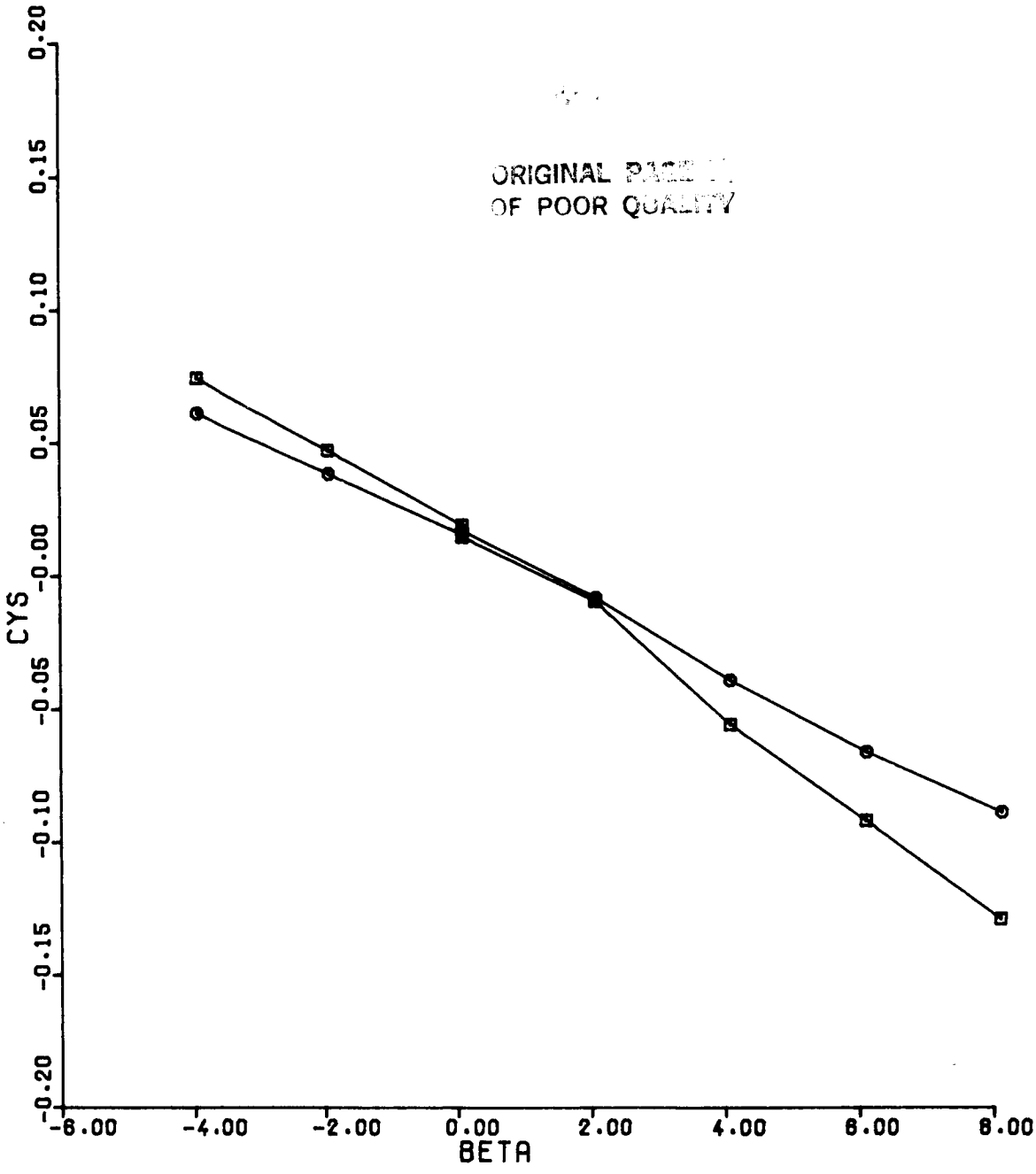

Figure 8(c). CYS vs BETA
Configuration 1, MACH = 0.6, DC = 0

SYMBOL	RUN	MACH
⊡	35	1.20
⊙	50	1.40
△	54	1.30
+	57	1.25

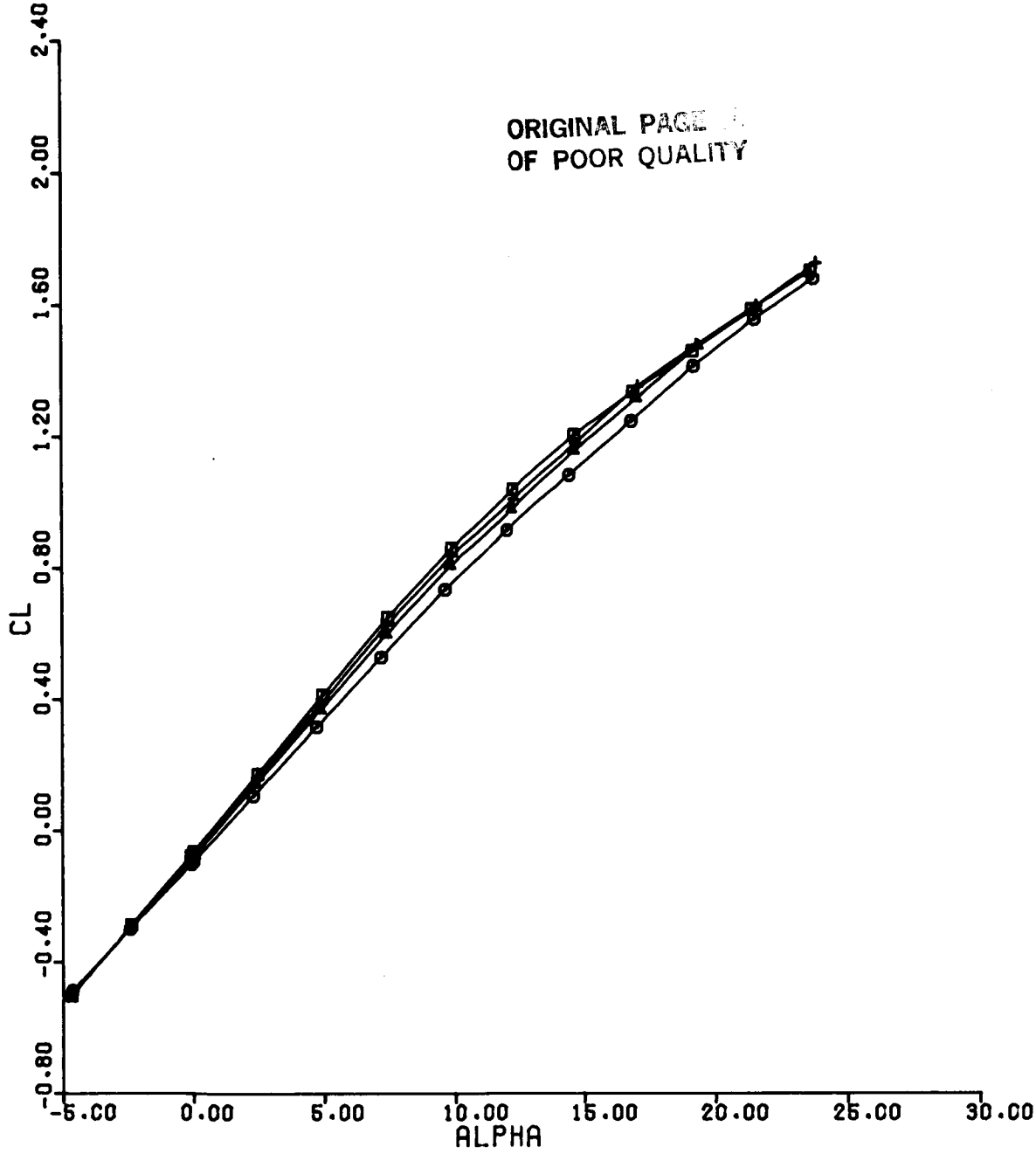

Figure 9(a). CL vs ALPHA
Configuration 1, BETA = 0, DC = 0

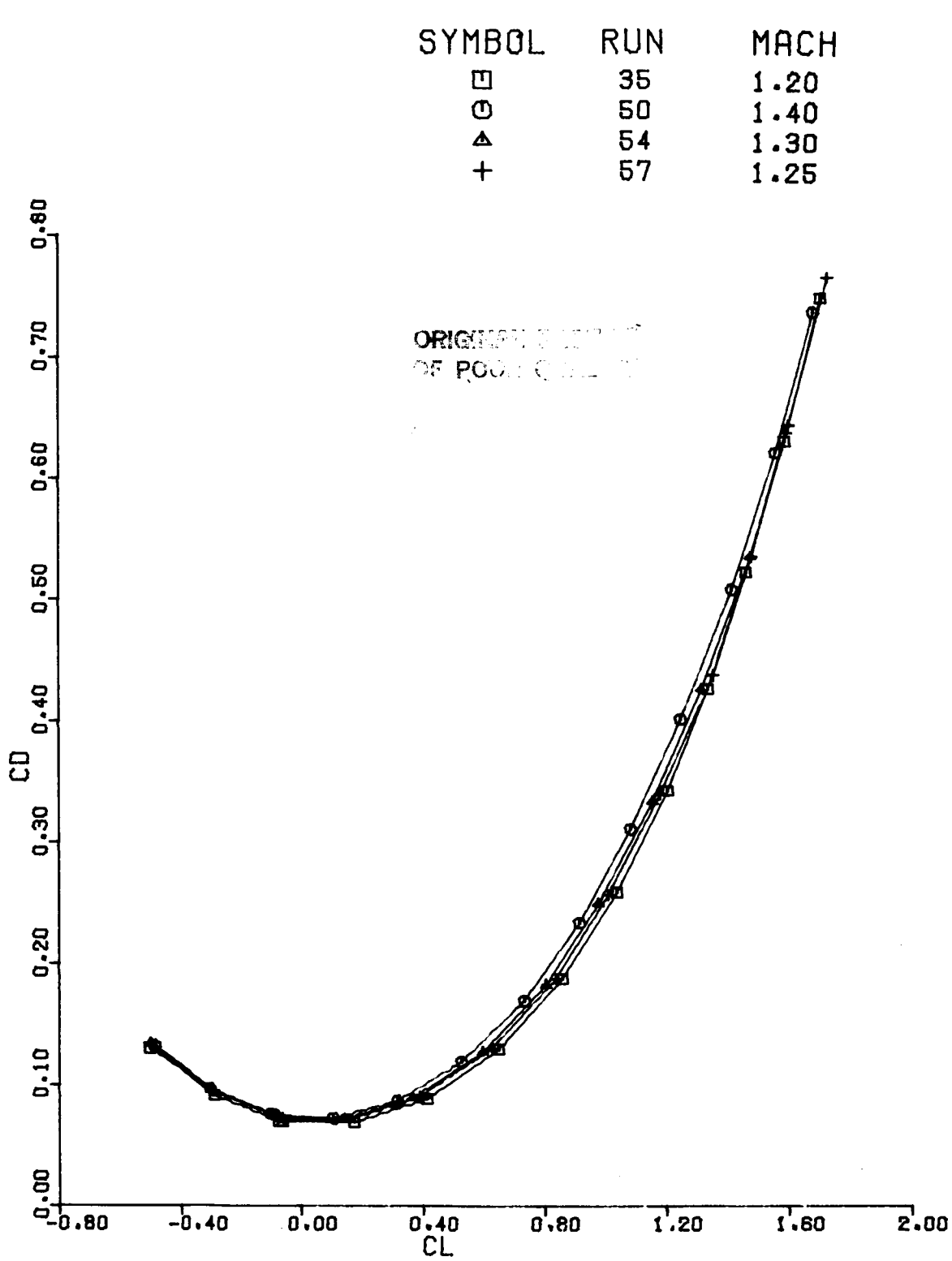

Figure 9(b). CD vs CL
Configuration 1, BETA = 0, DC = 0

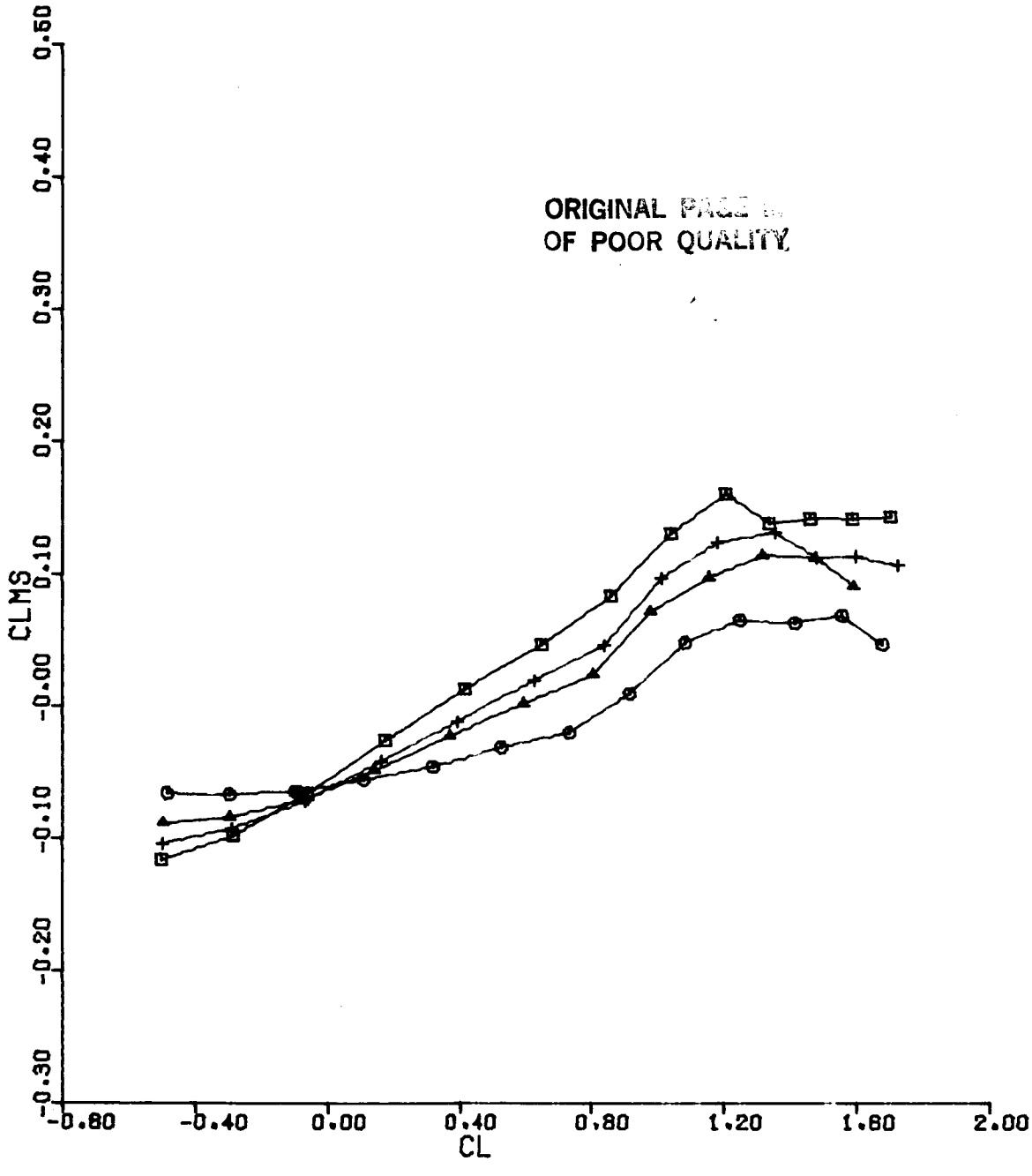

Figure 9(c). CLMS vs CL
Configuration 1, BETA = 0, DC = 0

SYMBOL	RUN	MACH
□	38	1.20
○	51	1.40
△	55	1.30
+	56	1.25

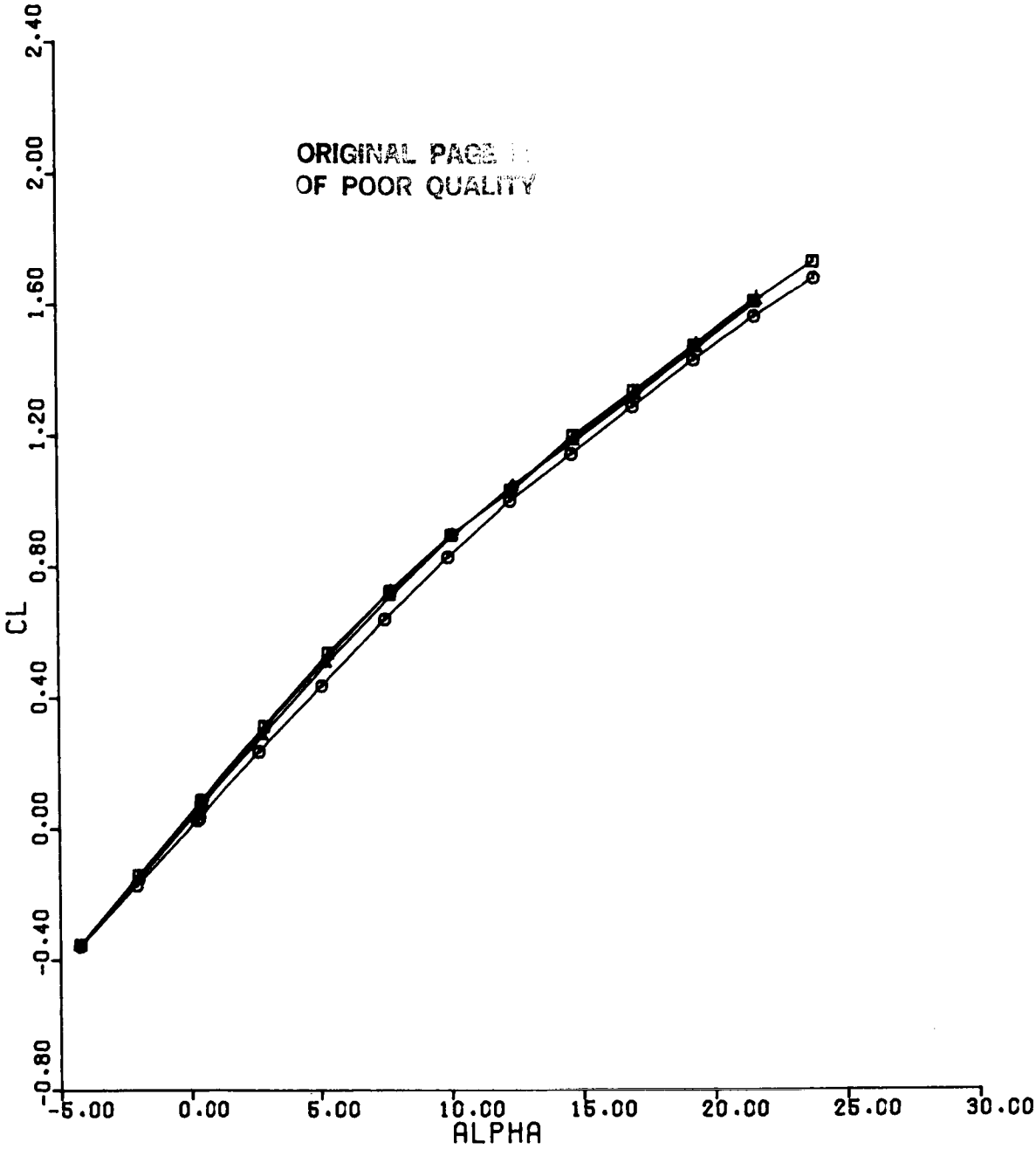

Figure 10(a). CL vs ALPHA
Configuration 1, BETA = 0, DC = 10

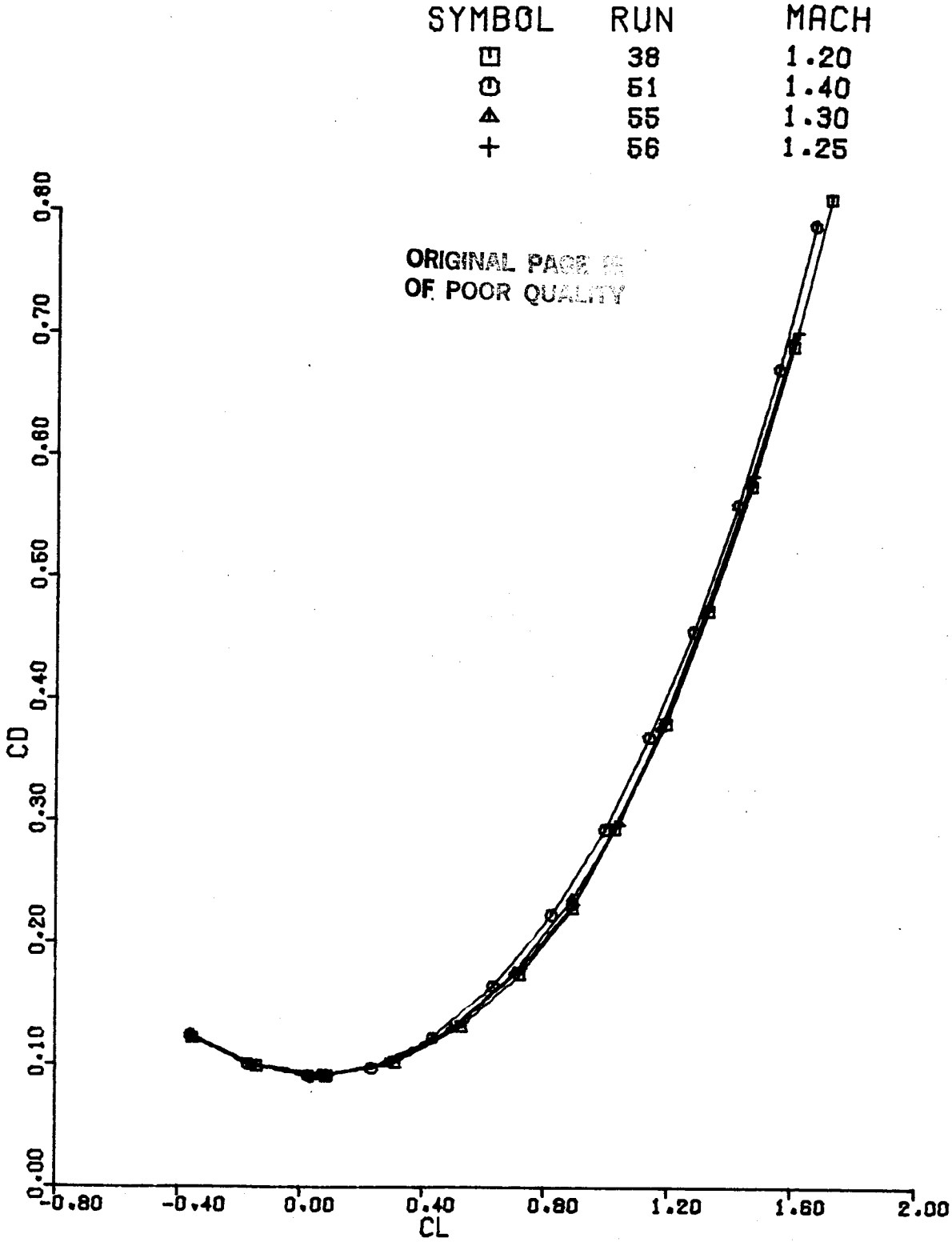

Figure 10(b). CD vs CL
Configuration 1, BETA = 0, DC = 10

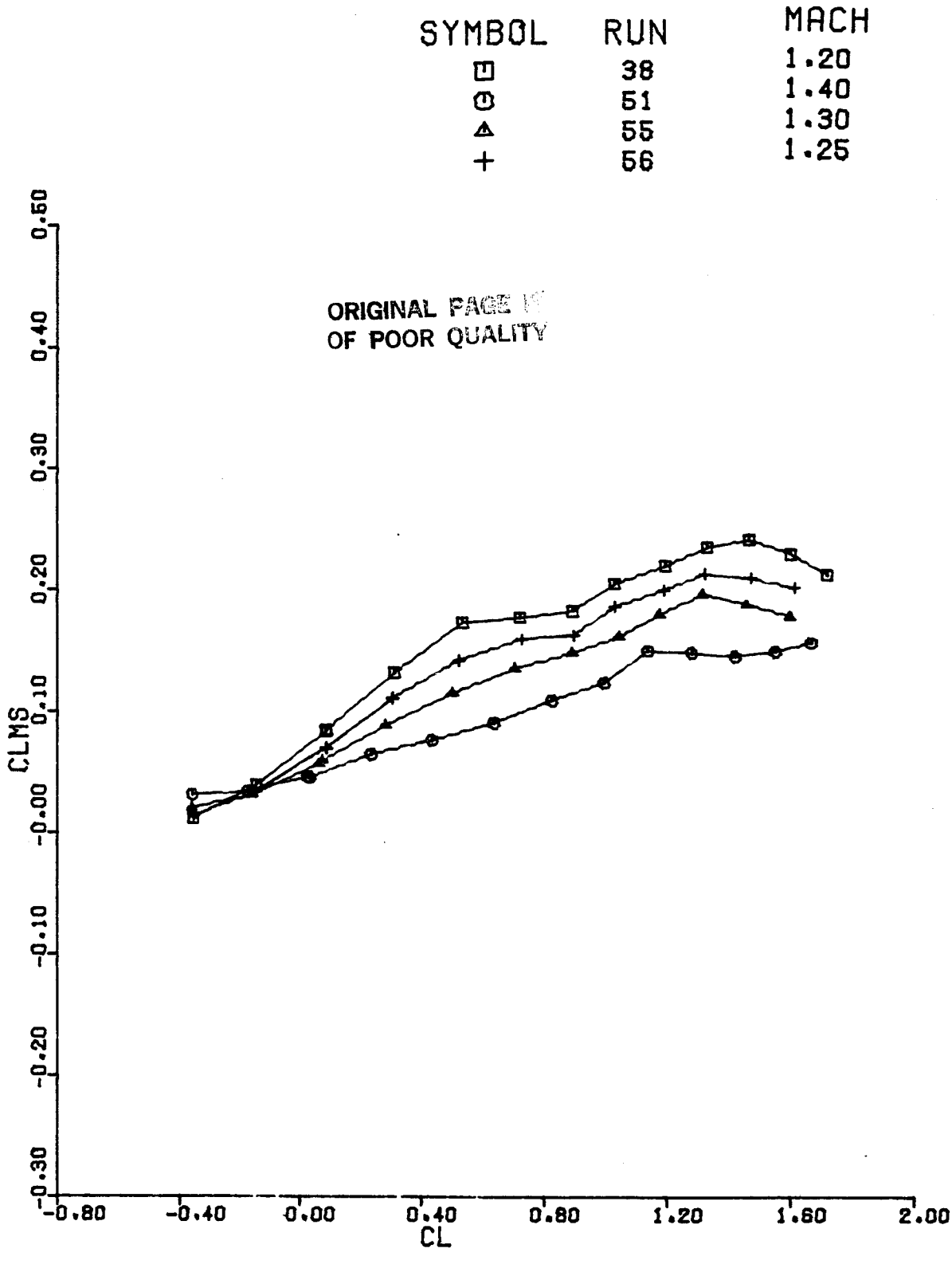

Figure 10(c). CLMS vs CL
Configuration 1, BETA = 0, DC = 10

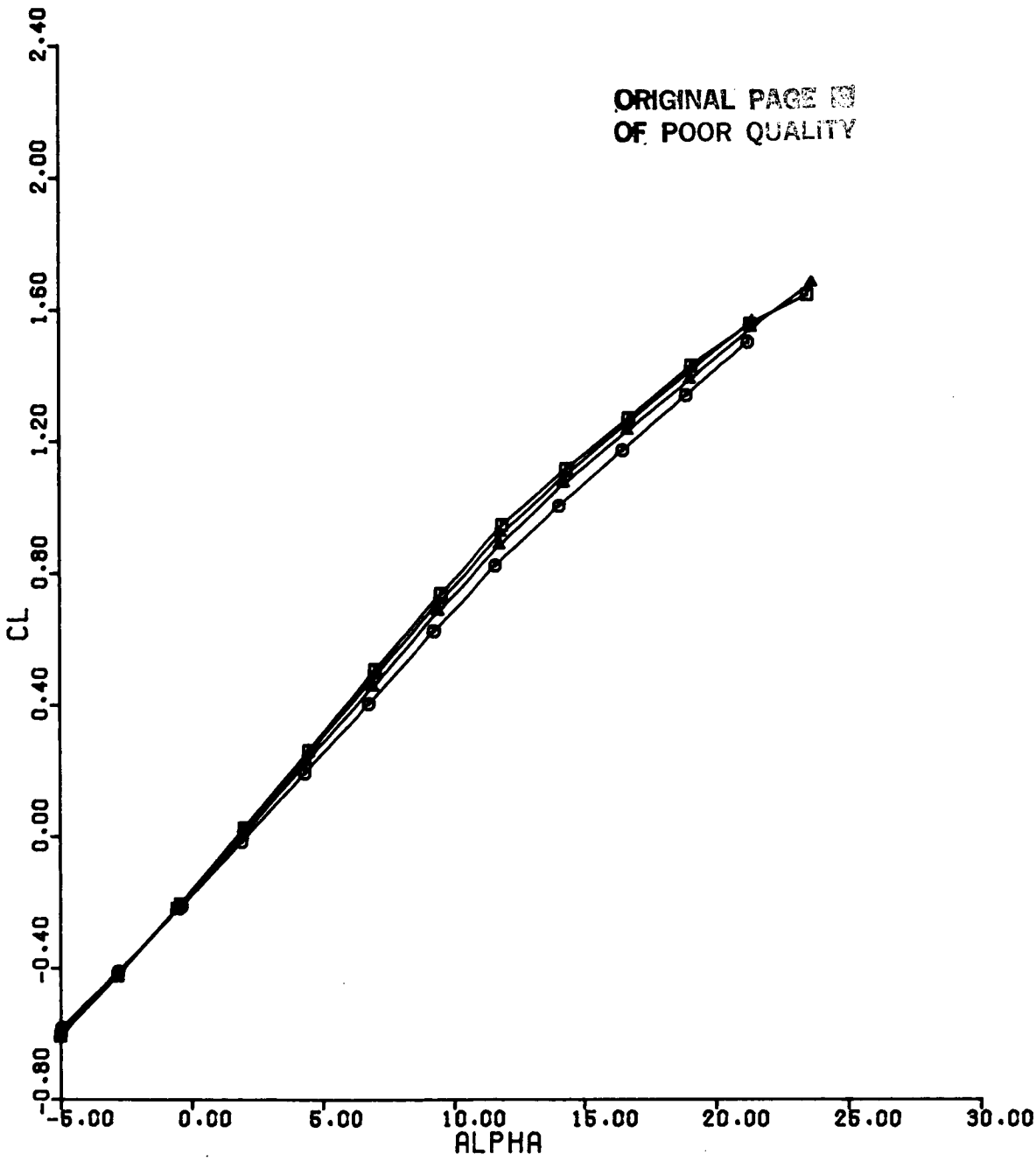

Figure 11(a). CL vs ALPHA
Configuration 1, BETA = 0, DC = -10

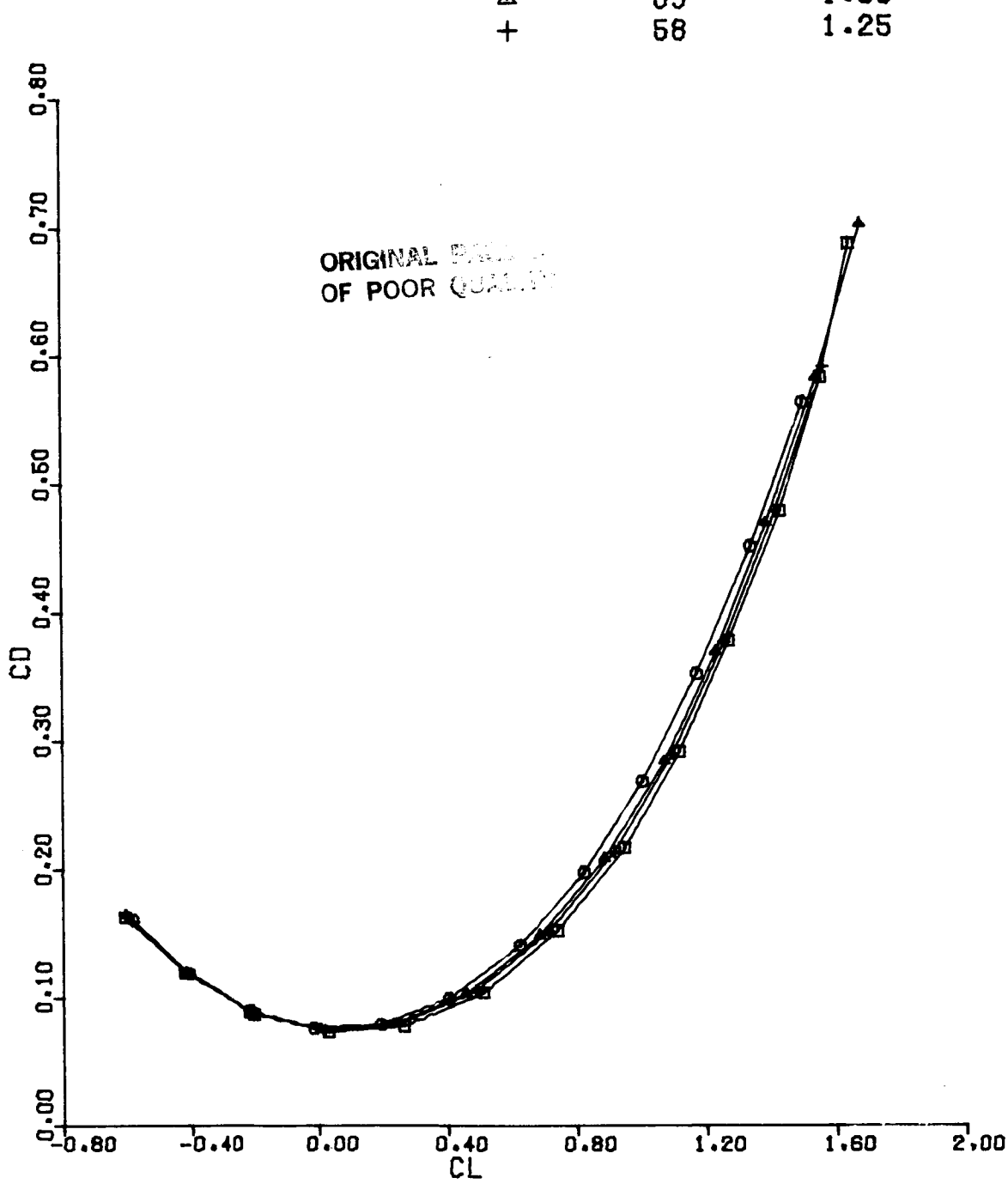

Figure 11(b). CD vs CL
Configuration 1, BETA = 0, DC = -10

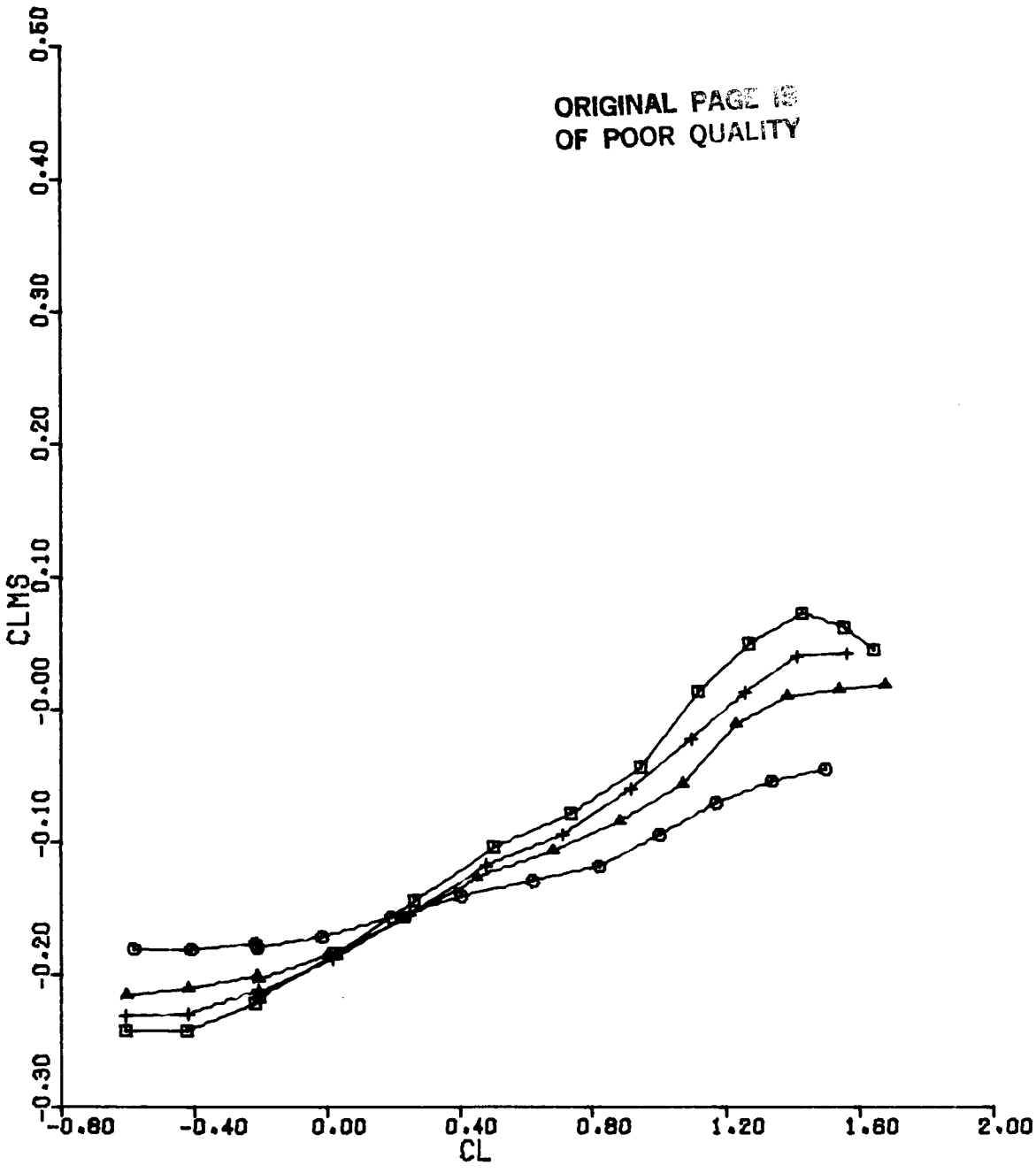

Figure 11(c). CLMS vs CL
Configuration 1, BETA = 0, DC = -10

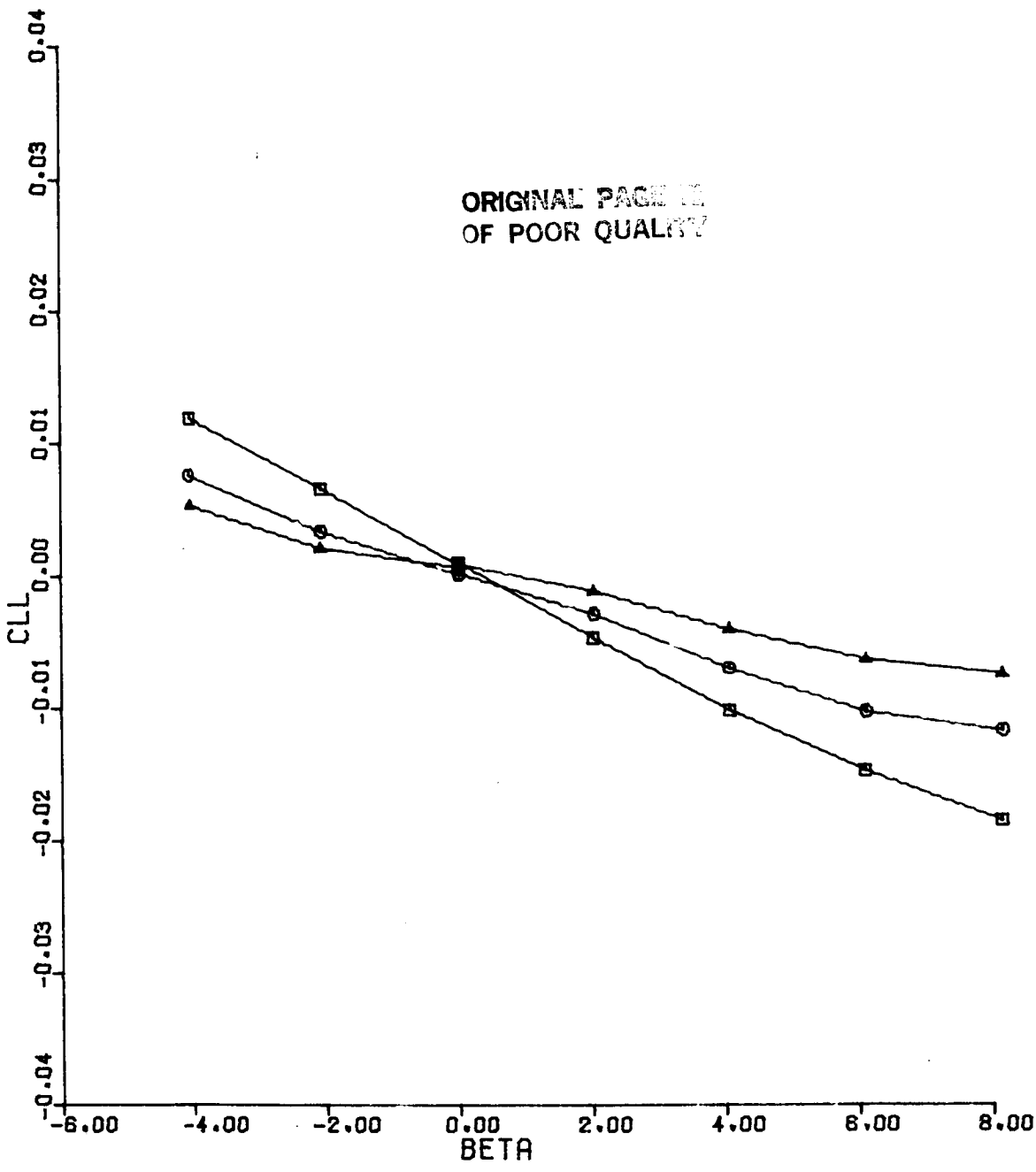

Figure 12(a). CLL vs BETA
Configuration 1, ALPHA = 10.9, MACH = 1.2

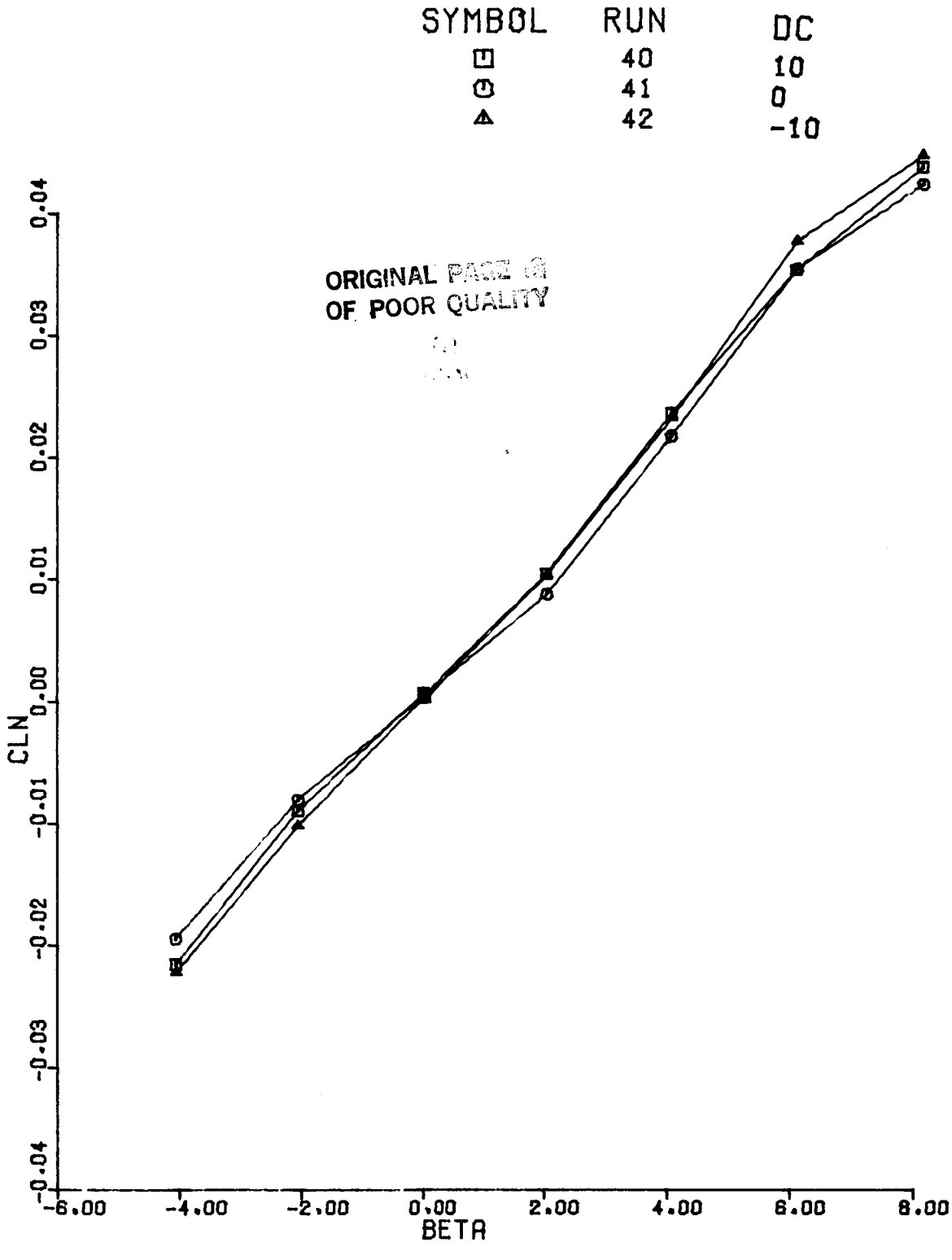

Figure 12(b). CLN vs BETA
Configuration 1, ALPHA = 10.9, MACH = 1.2

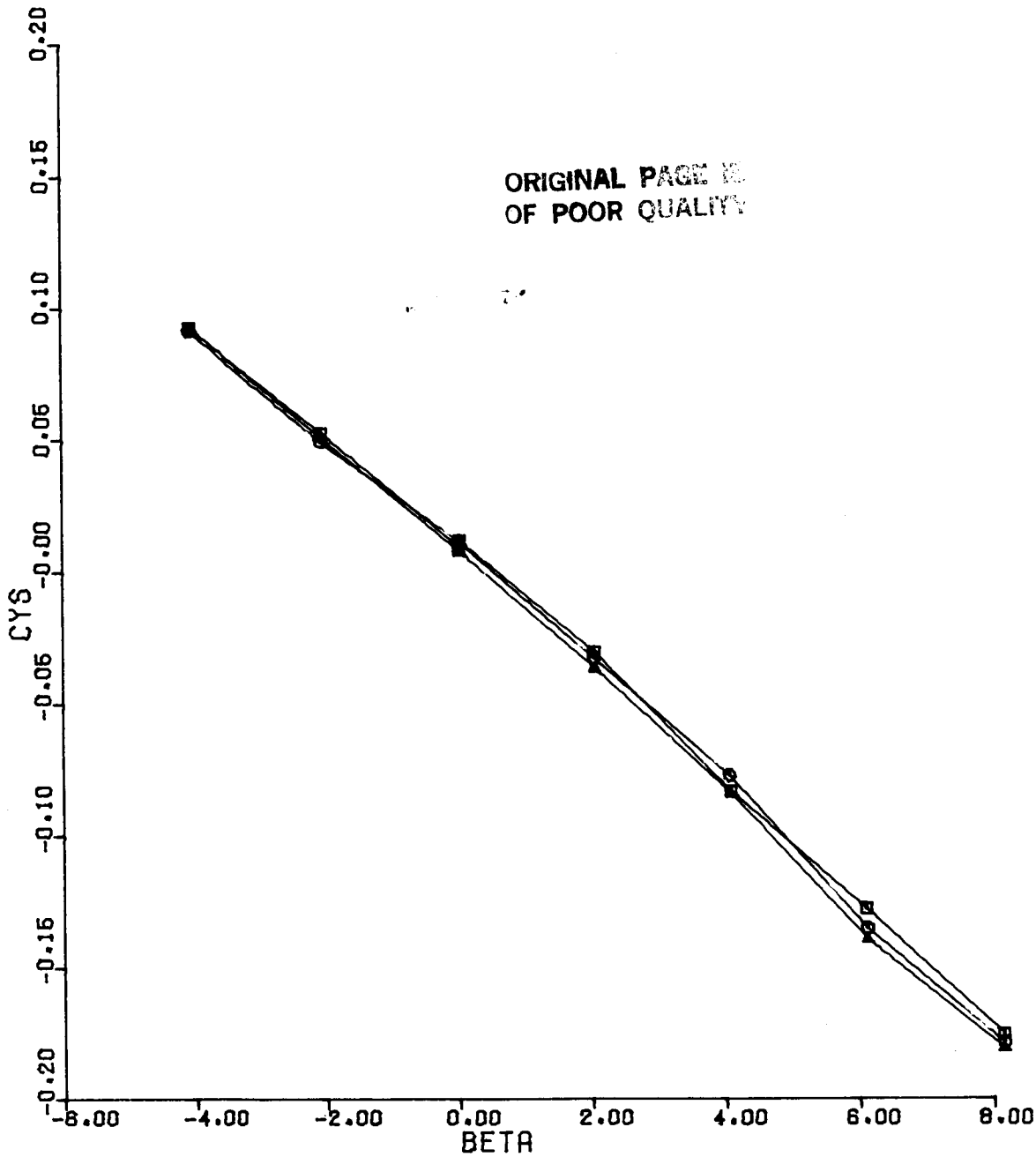

Figure 12(c). CYS vs BETA
Configuration 1, ALPHA = 10.9, MACH = 1.2

SYMBOL	RUN	DC
□	43	10
○	44	0
△	45	-10

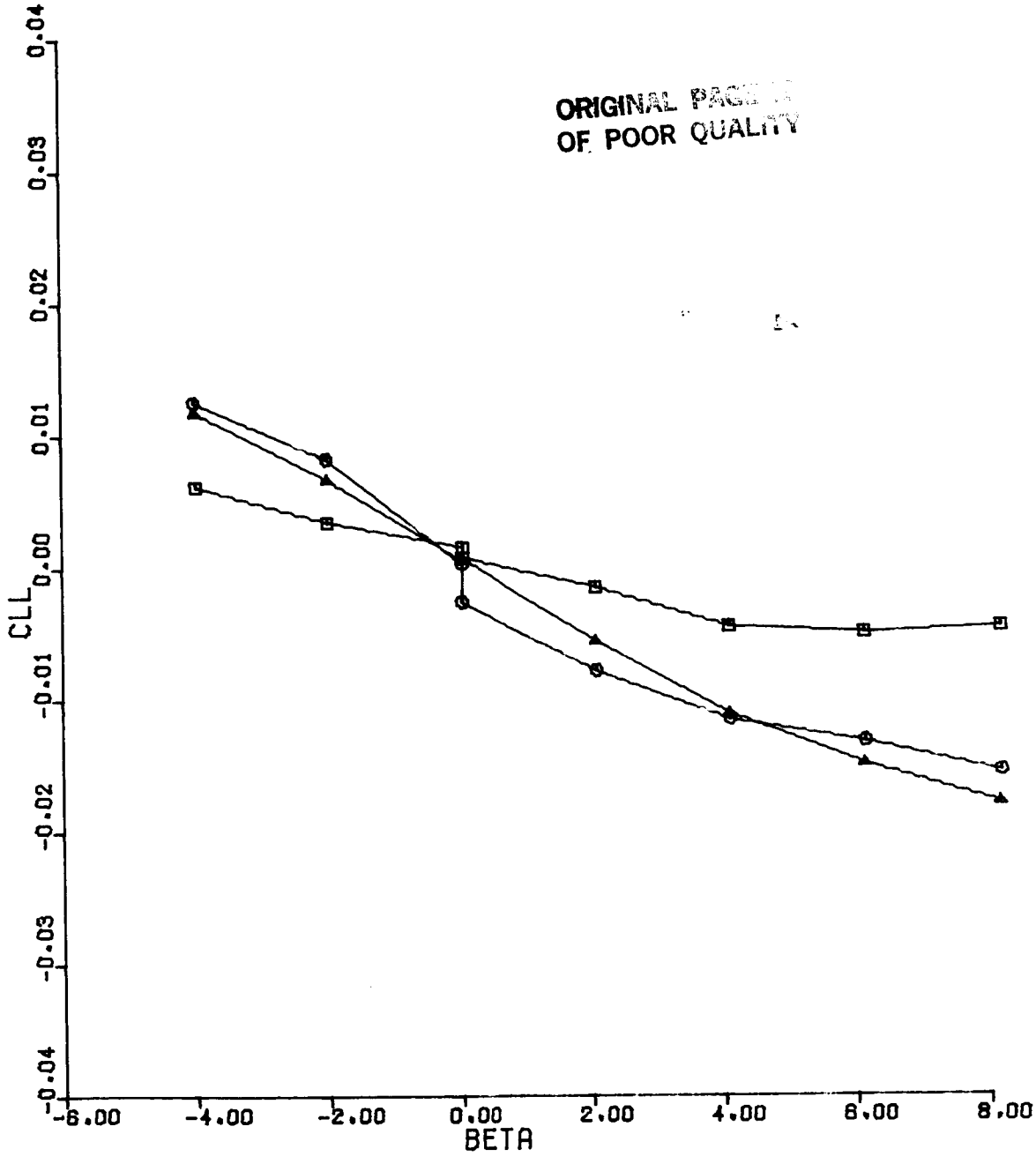

Figure 13(a). CLL vs BETA
Configuration 1, MACH = 1.2, ALPHA = 16.2

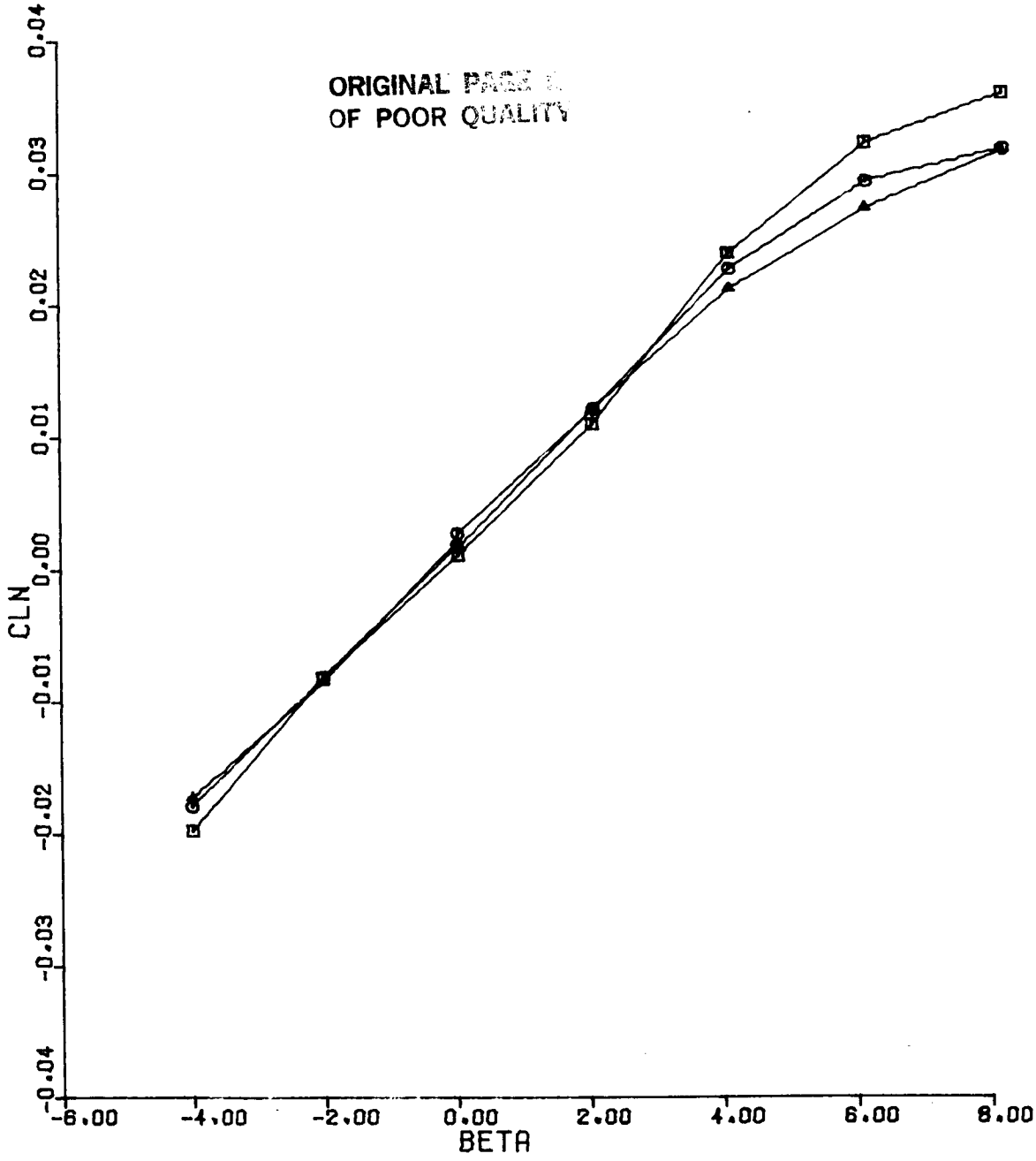

Figure 13(b). CLN vs BETA
Configuration 1, MACH = 1.2, ALPHA = 16.2

SYMBOL	RUN	DC
□	43	10
○	44	0
△	45	-10

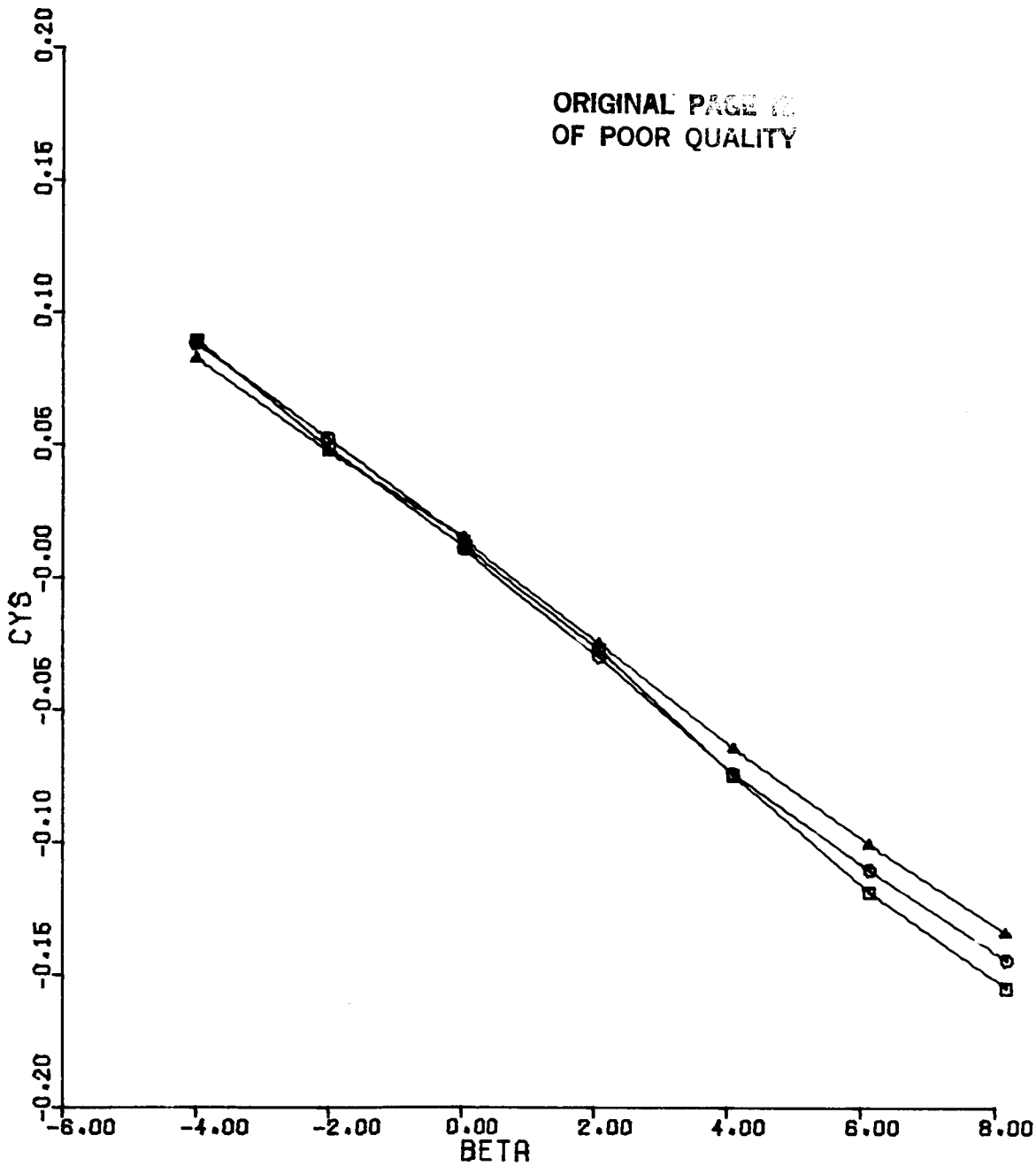

Figure 13(c). CYS vs BETA
Configuration 1, MACH = 1.2, ALPHA = 16.2

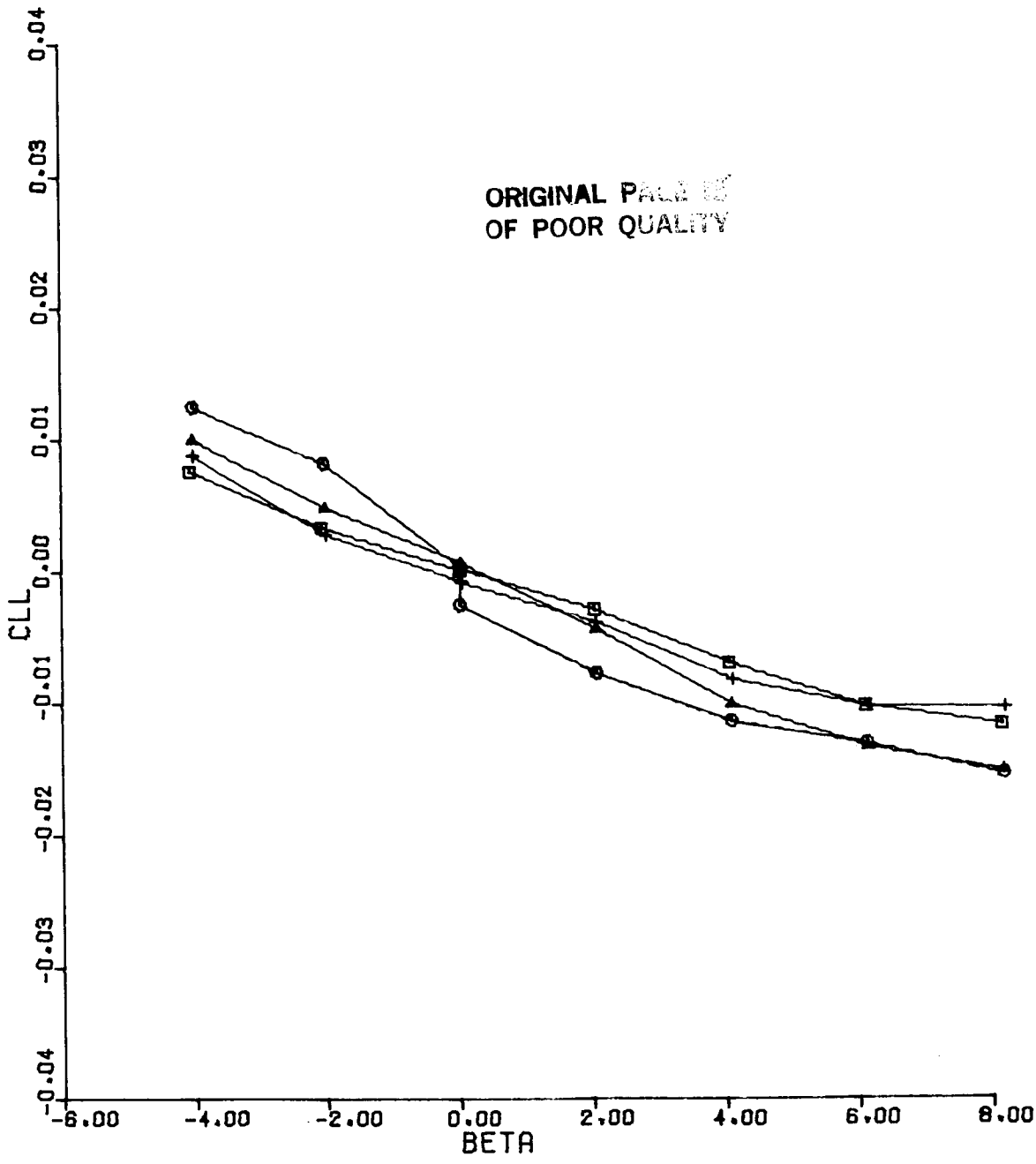

Figure 14(a). CLL vs BETA
Configuration 1, MACH = 1.2, DC = 0

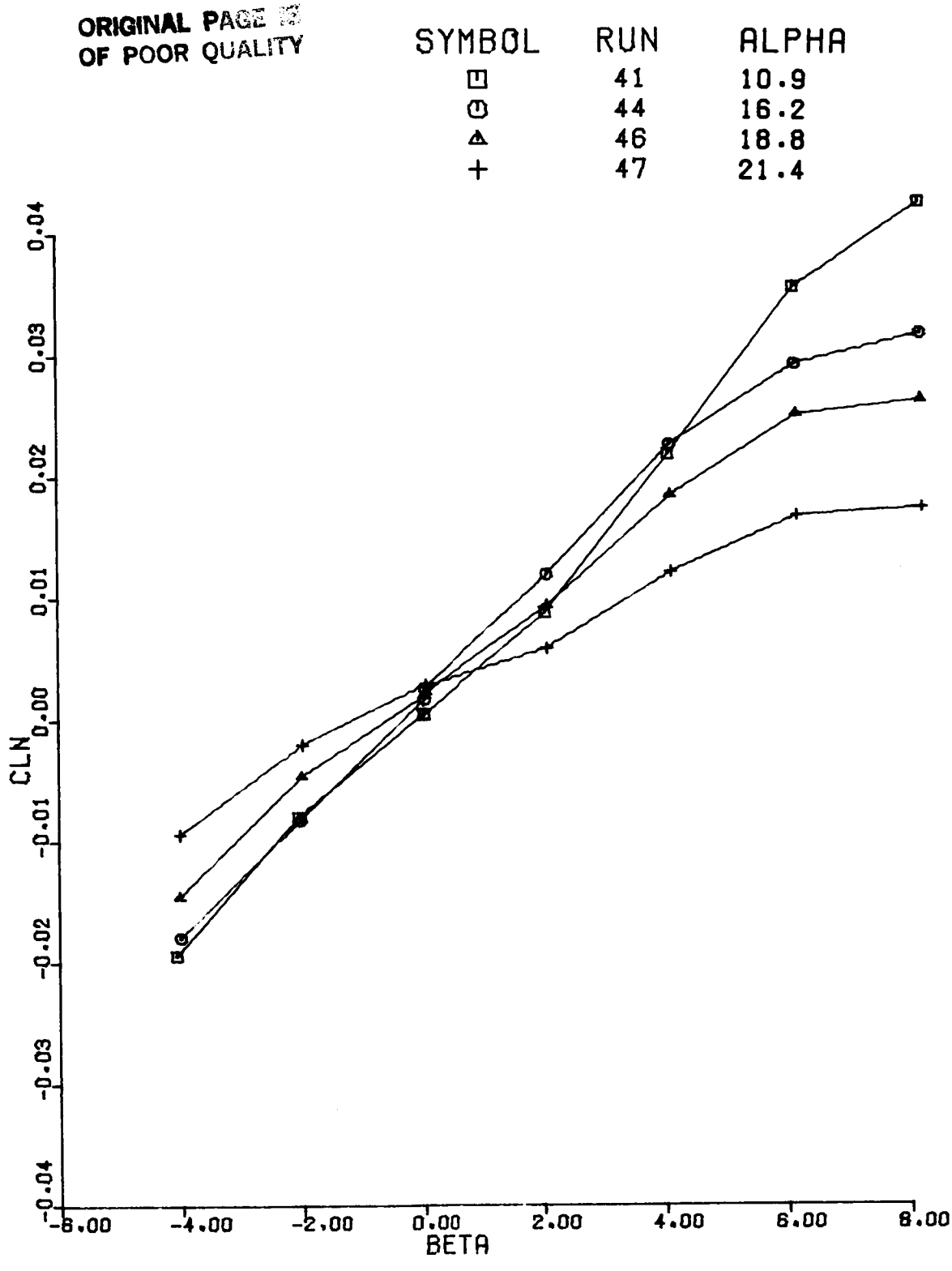

Figure 14(b). CLN vs BETA
Configuration 1, MACH = 1.2, DC = 0

SYMBOL	RUN	ALPHA
□	41	10.9
○	44	16.2
△	46	18.8
+	47	21.4

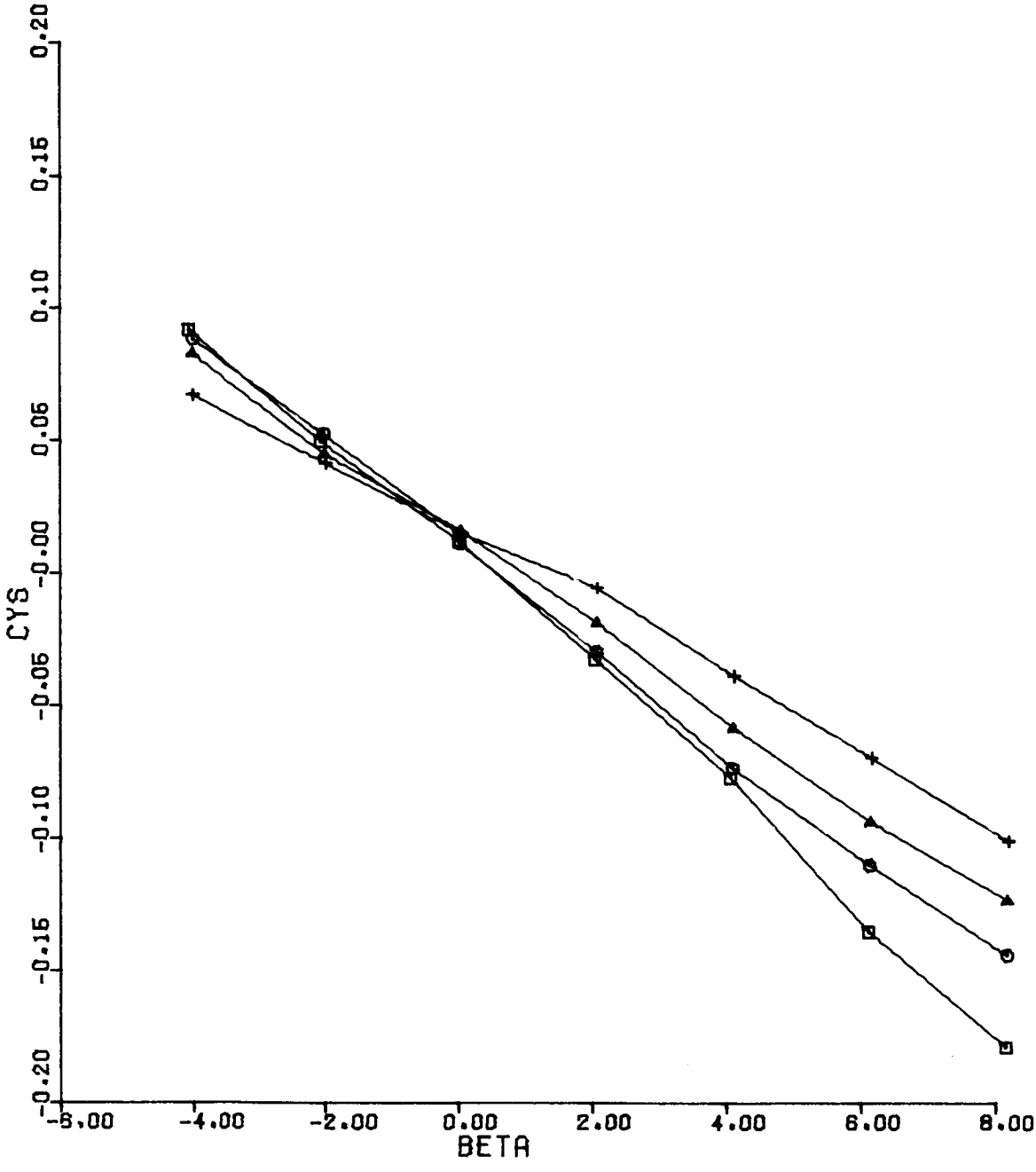

Figure 14(c). CYS vs BETA
Configuration 1, MACH = 1.2, DC = 0

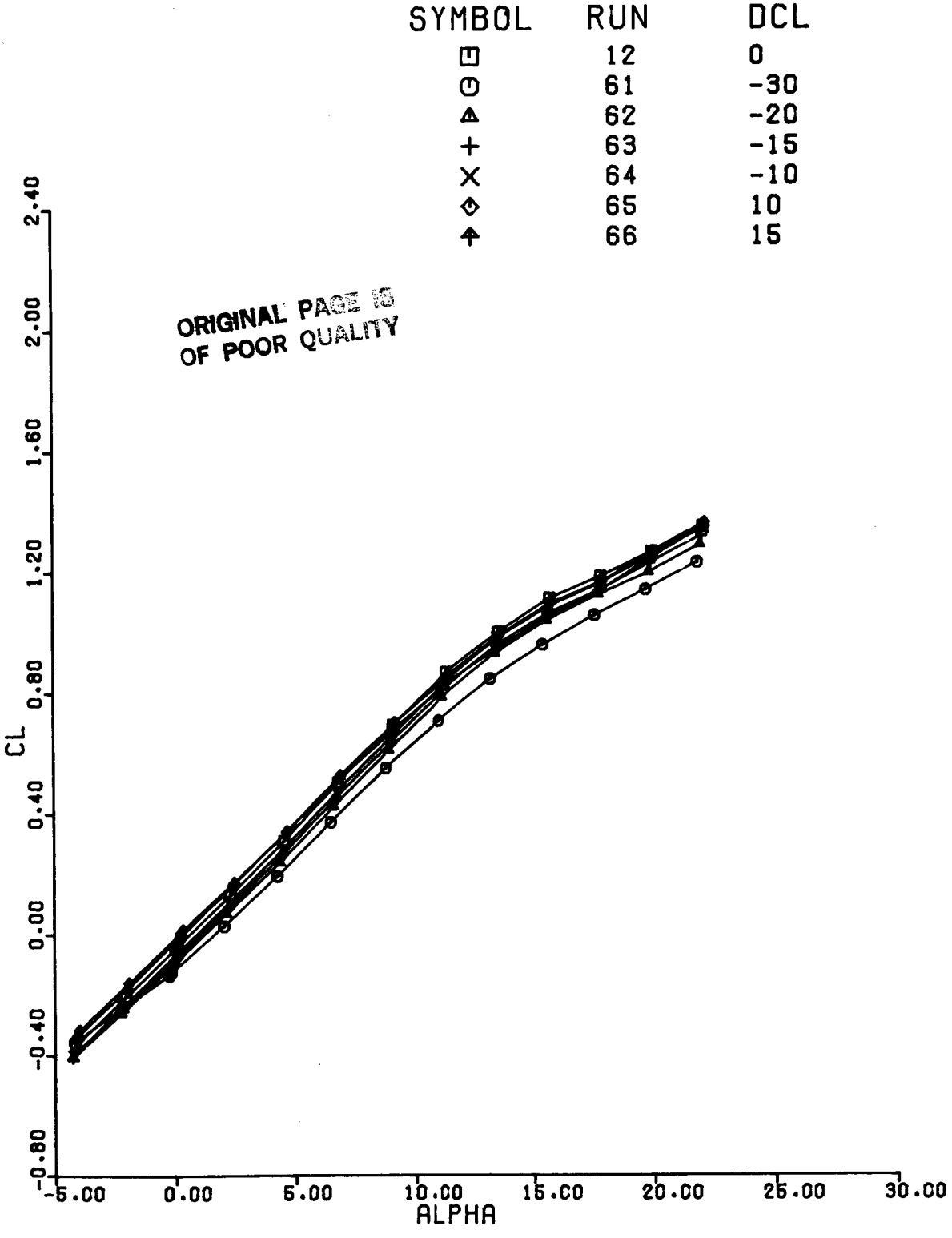

Figure 15(a). CL vs ALPHA, DCR = 0, Configuration 1, MACH = 0.6, BETA = 0

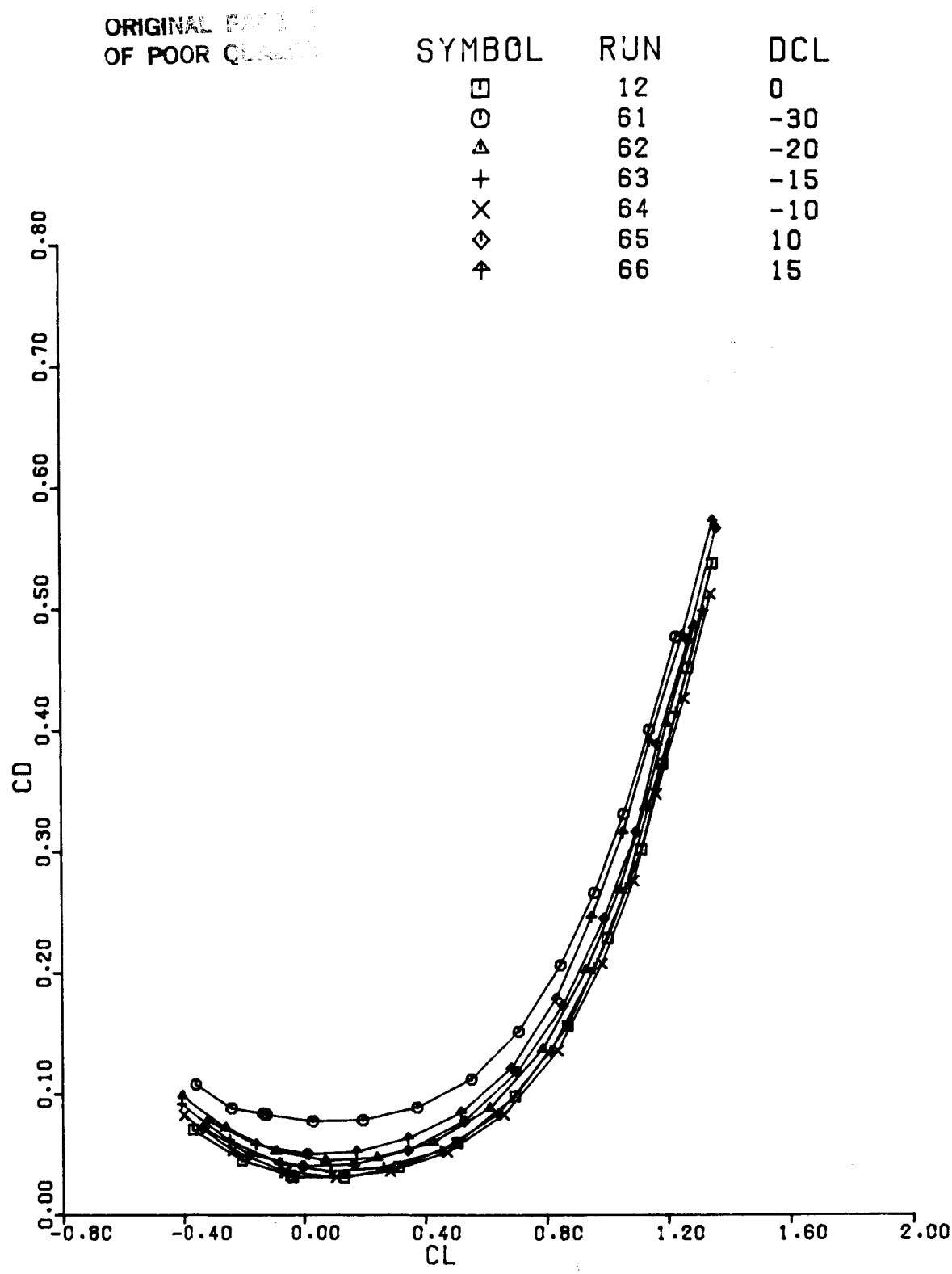

Figure 15(b). CD vs CL, DCR = 0,
Configuration 1, MACH = 0.6, BETA = 0

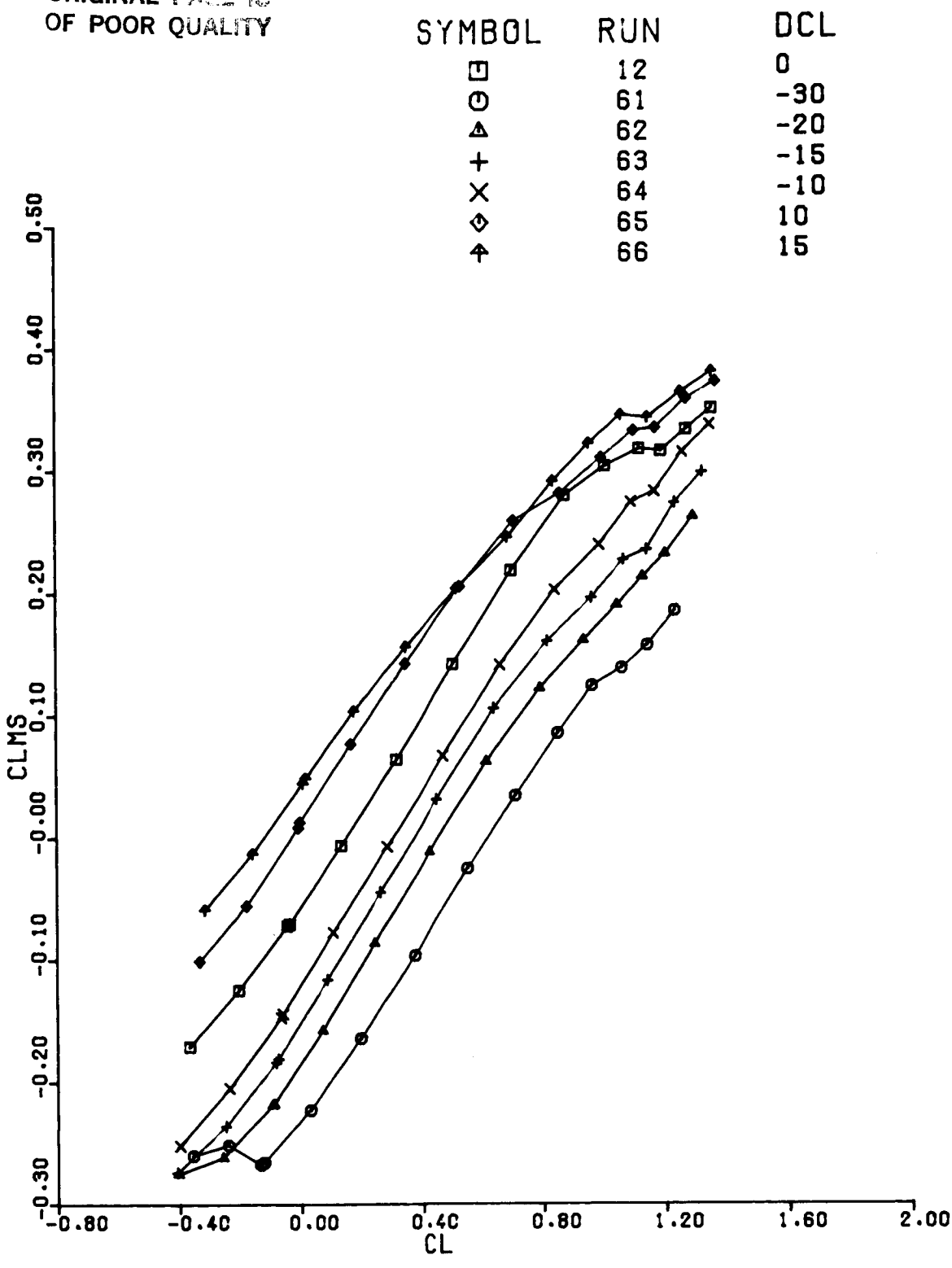

Figure 15(c). CLMS vs CL, DCR = 0,
Configuration 1, MACH = 0.6, BETA = 0

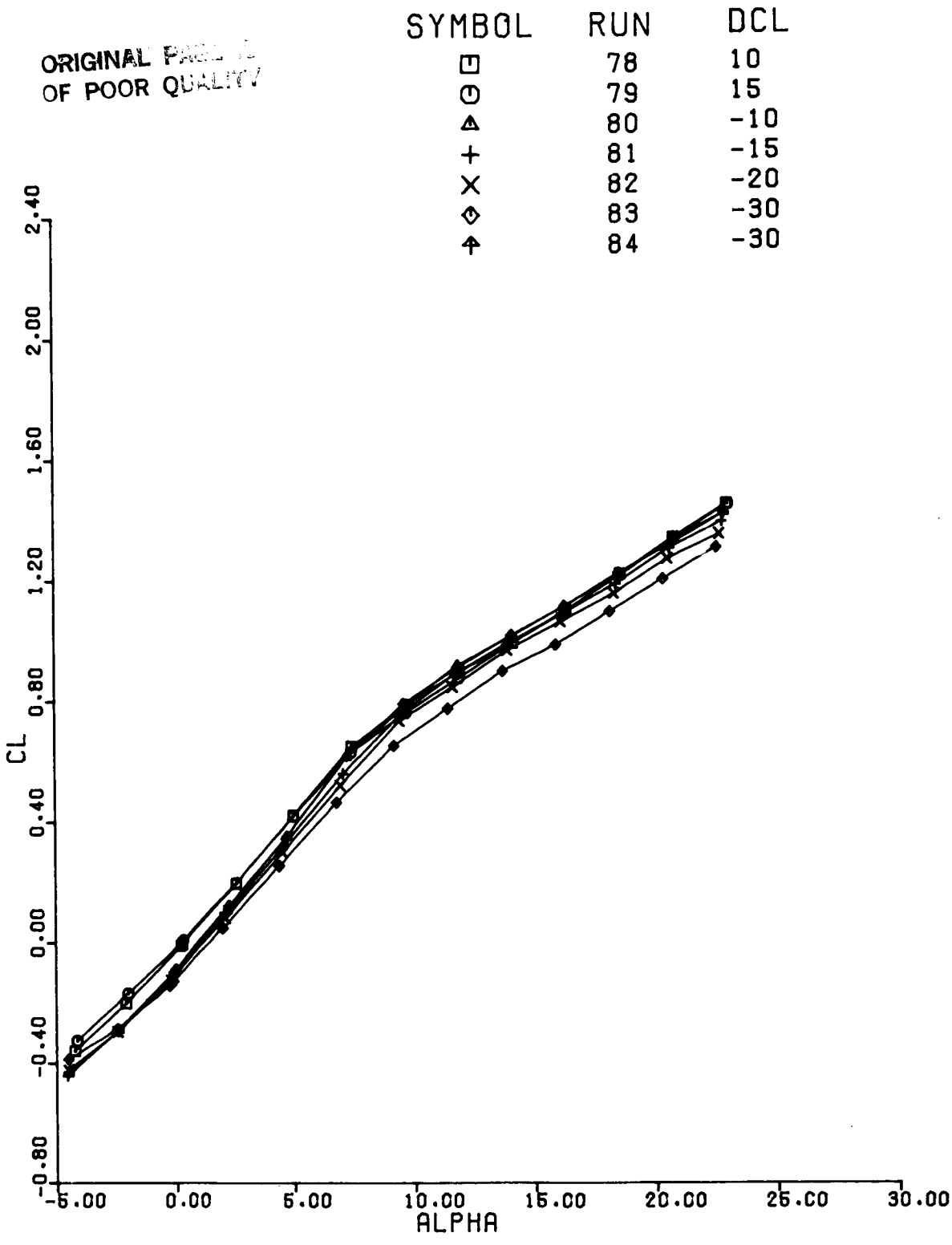

Figure 16(a). CL vs ALPHA, DCR = 0,
Configuration 1, MACH = 0.9, BETA = 0

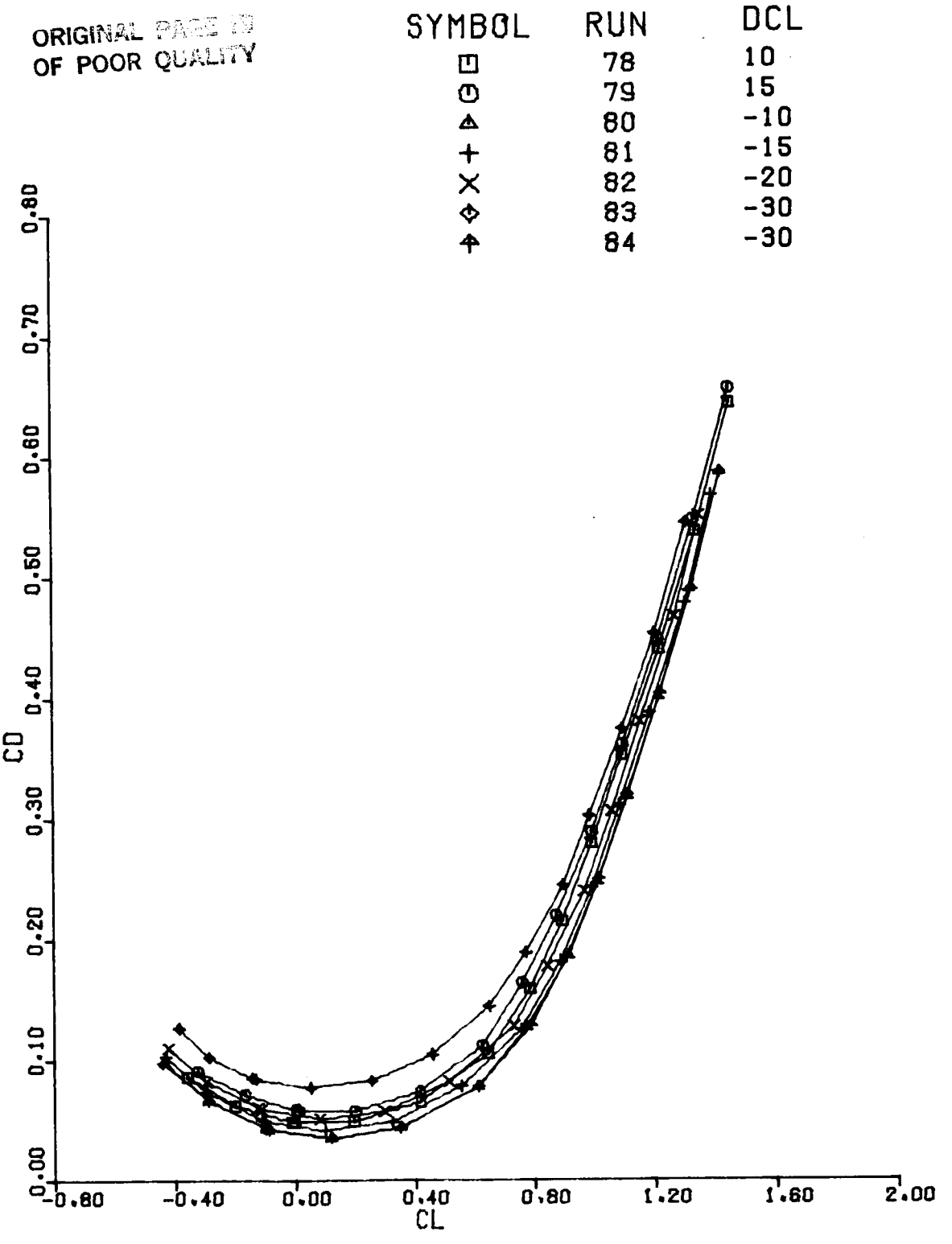

Figure 16(b). CD vs CL
Configuration 1, MACH = 0.9, BETA = 0

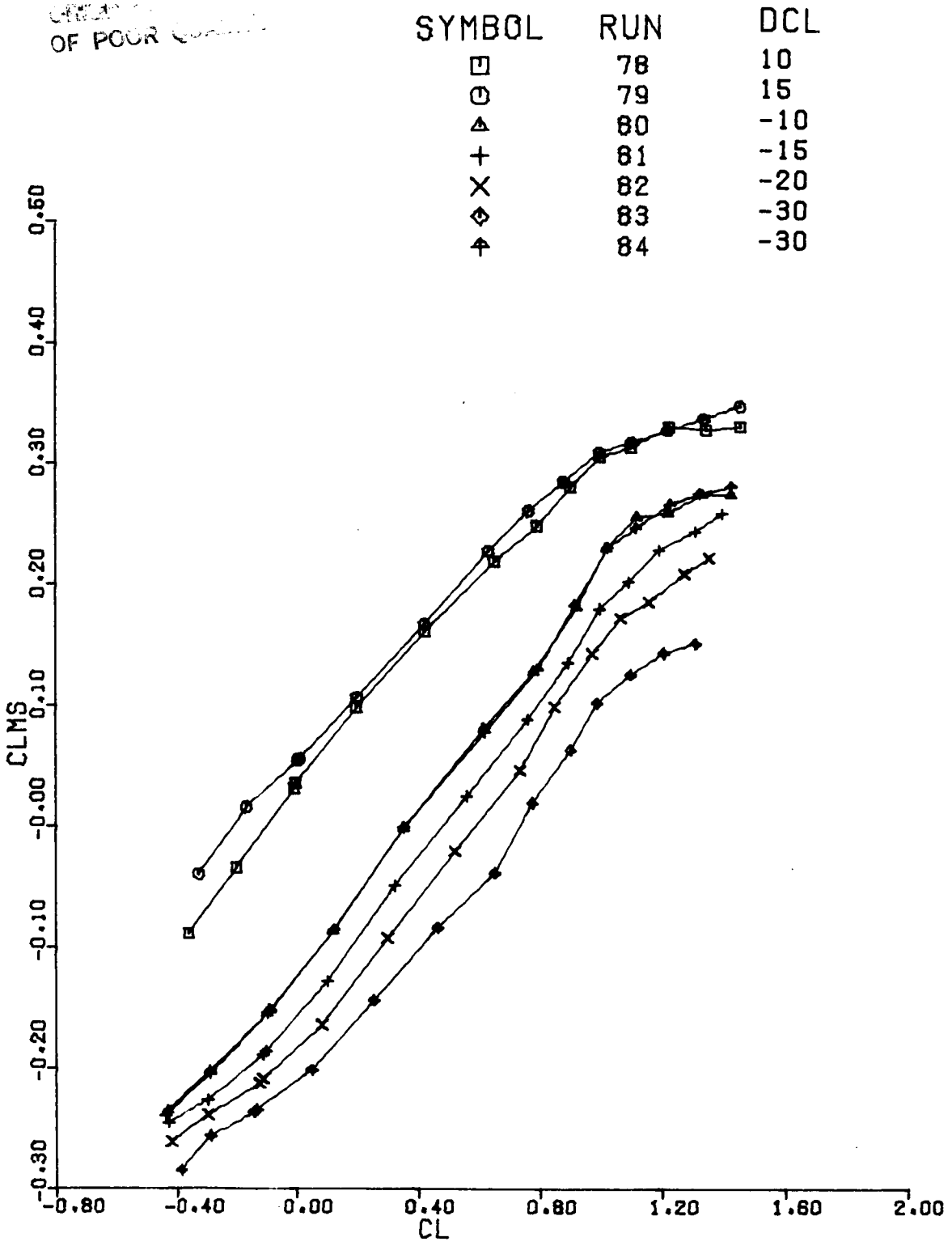

Figure 16(c). CLMS vs CL
Configuration 1, MACH = 0.9, BETA = 0

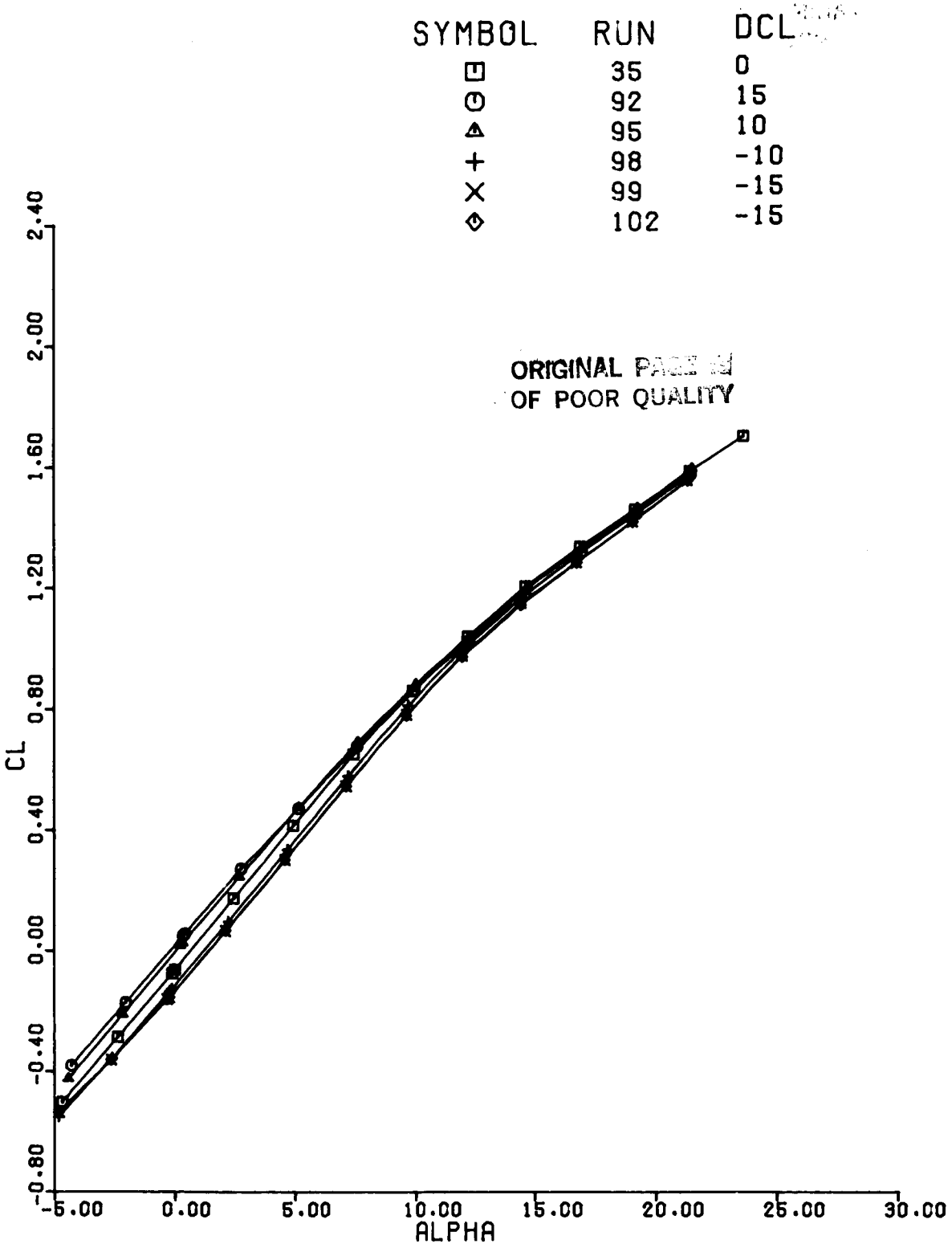

Figure 17(a). CL vs ALPHA, DCR = 0, Configuration 1, MACH = 1.2, BETA = 0

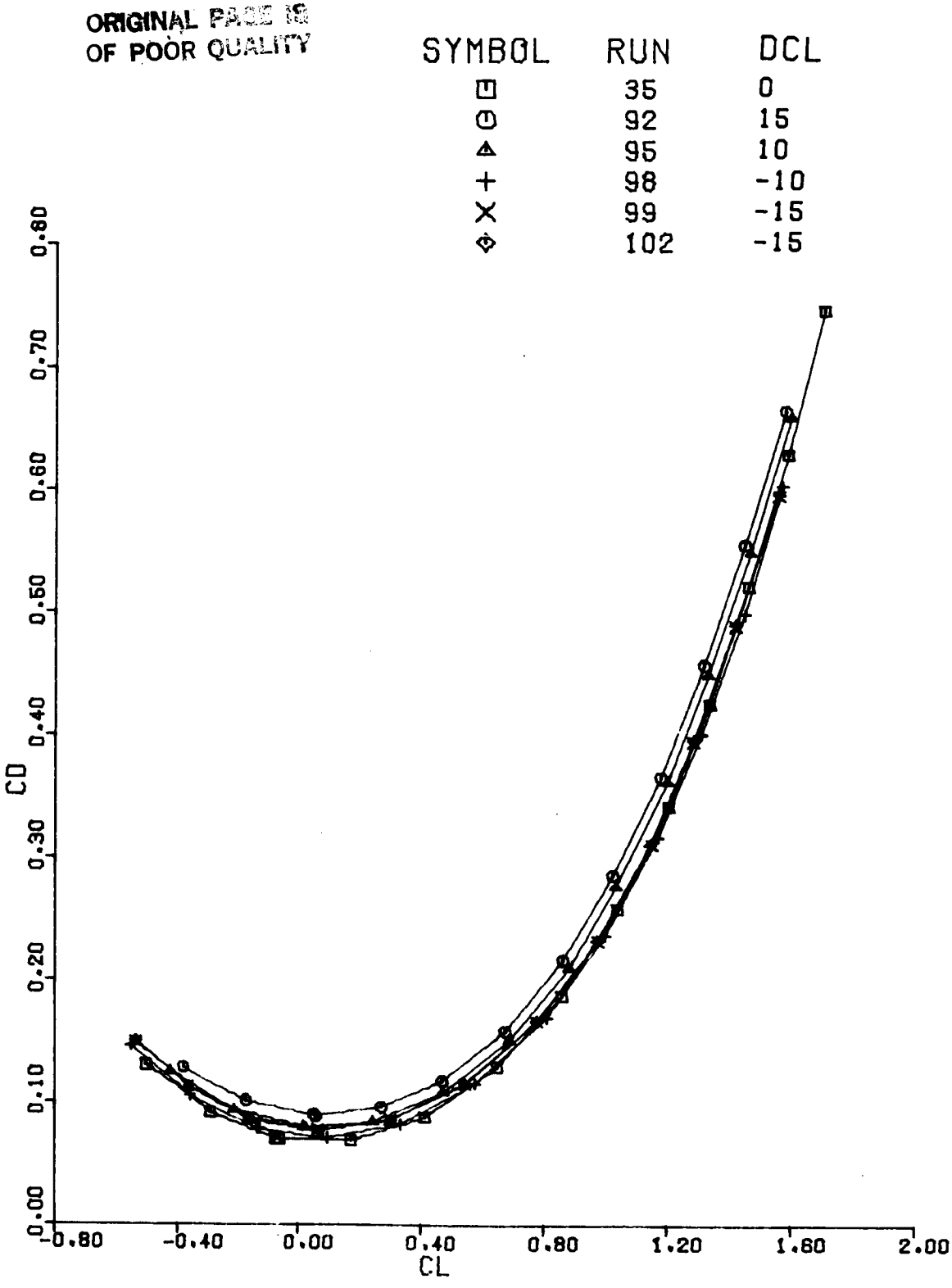

Figure 17(b). CD vs CL, DCR = 0,
Configuration 1, MACH = 1.2, BETA = 0

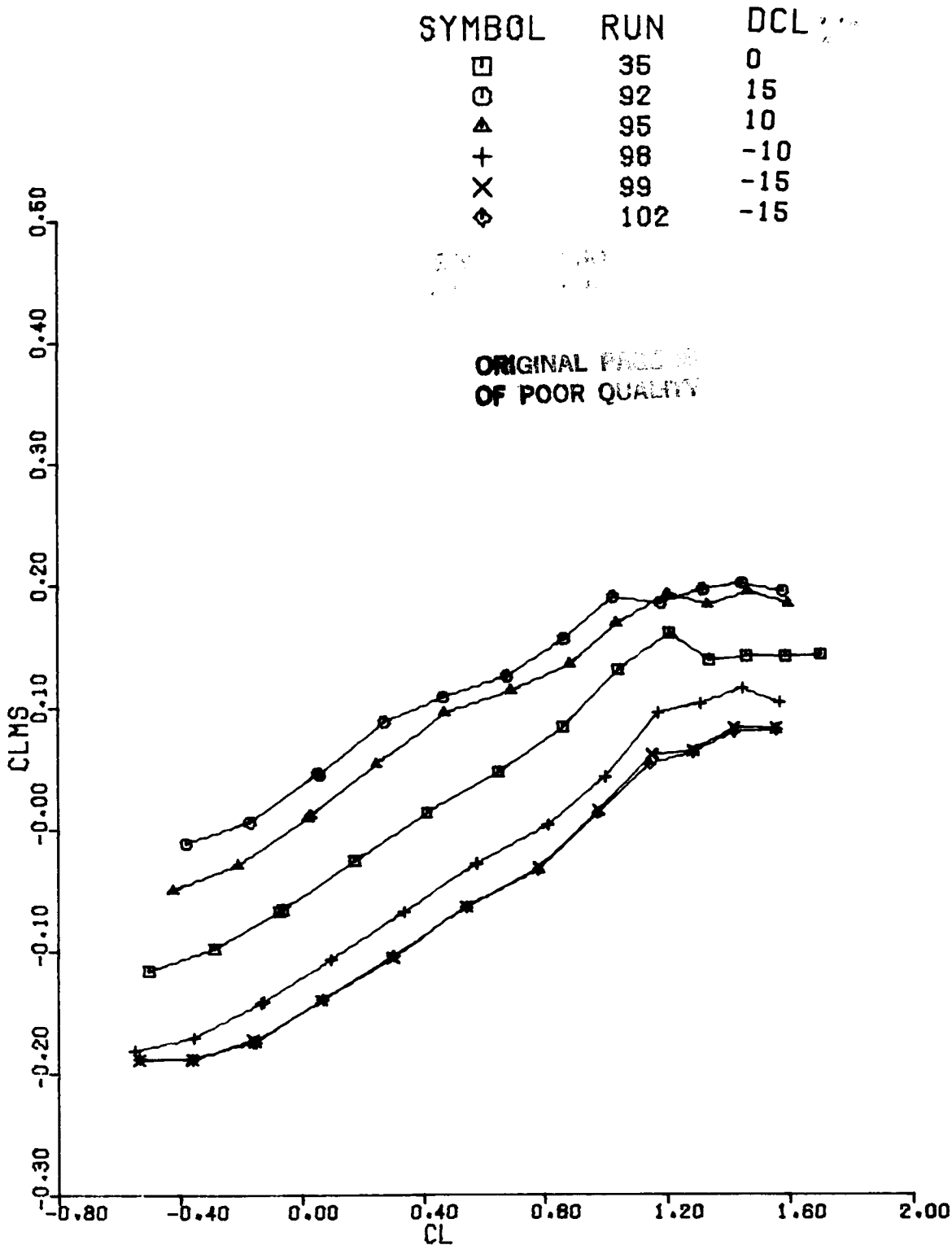

Figure 17(c). CLMS vs CL, DCR = 0, Configuration 1, MACH = 1.2, BETA = 0

SYMBOL	RUN	BETA
□	32	4
○	33	8

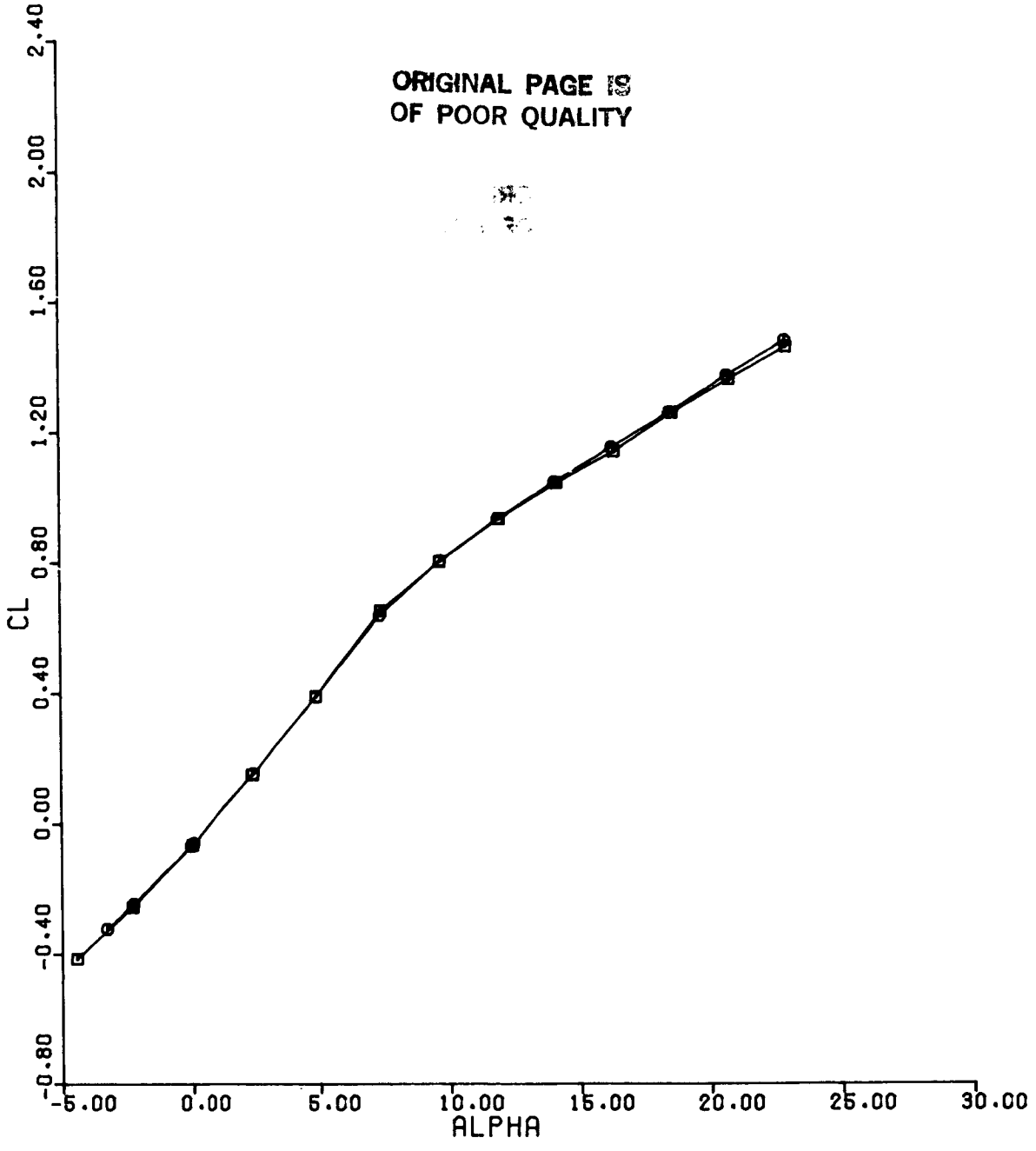

Figure 18(a). CL vs ALPHA
Configuration 1, MACH = 0.9, DC = 0

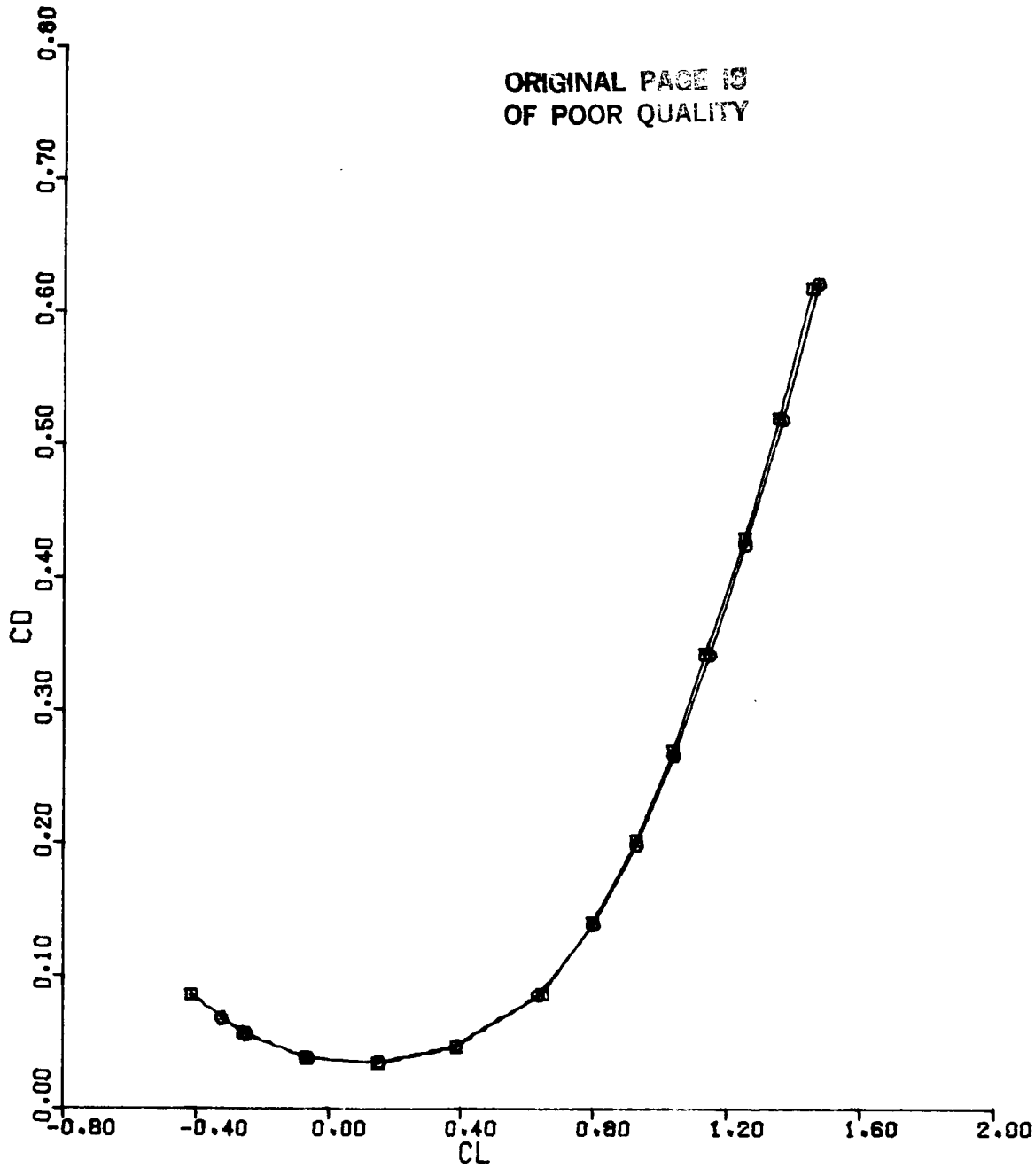

Figure 18(b). CD vs CL
Configuration 1, MACH = 0.9, DC = 0

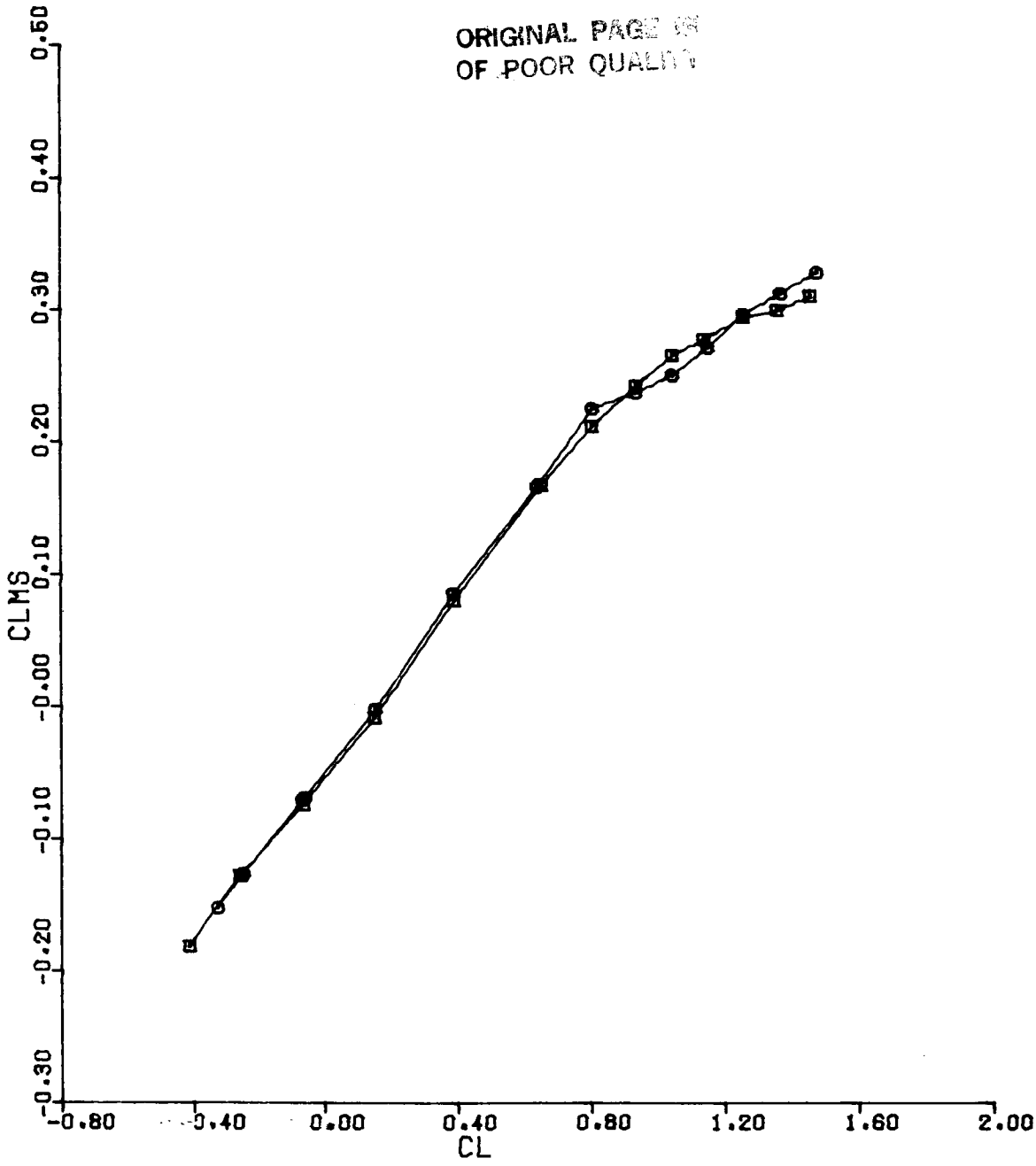

Figure 18(c). CLMS vs CL
Configuration 1, MACH = 0.9, DC = 0

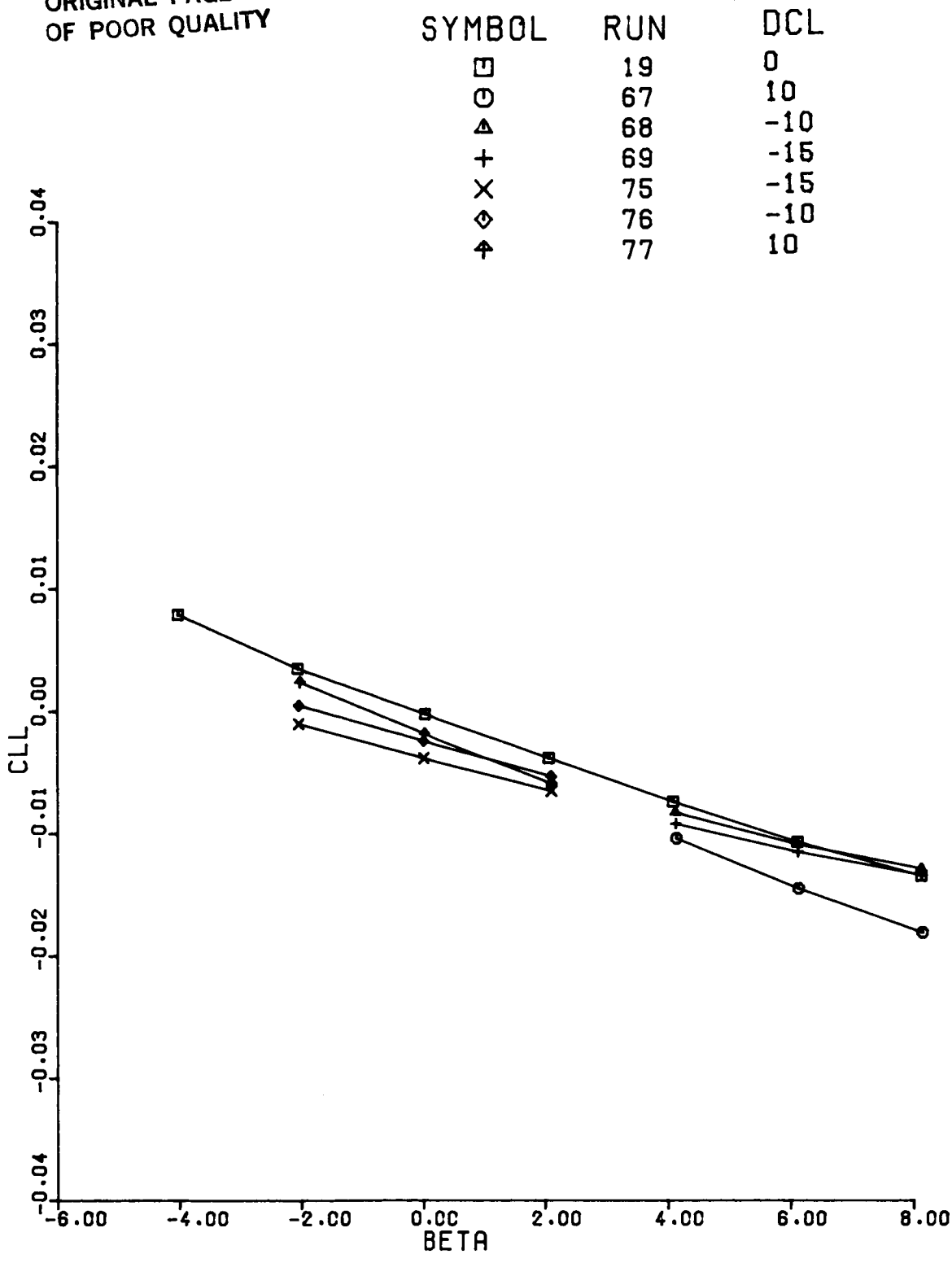

Figure 19(a). CLL vs BETA, DCR = 0,
Configuration 1, ALPHA = 10, MACH = 0.6

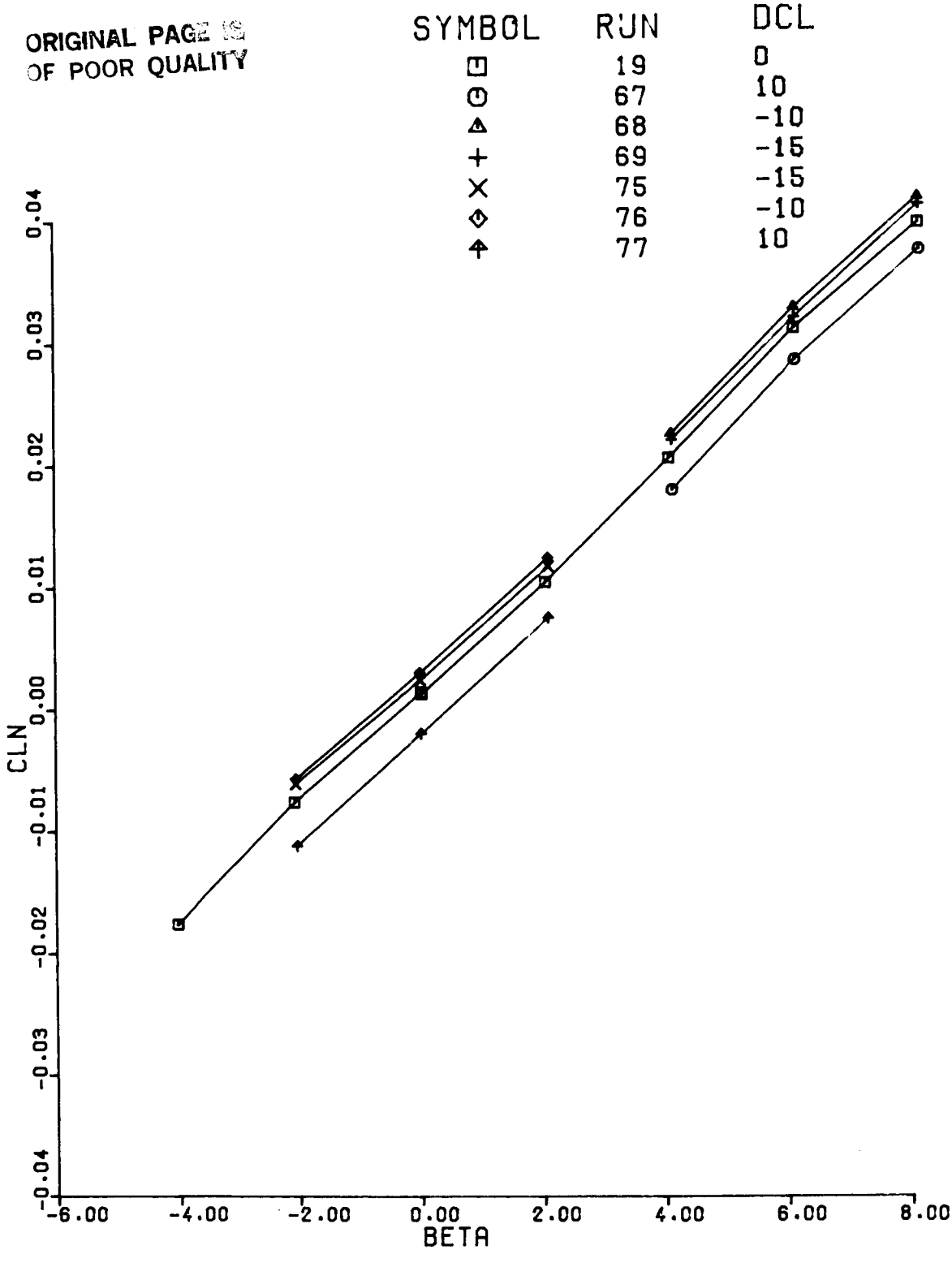

Figure 19(b). CLN vs BETA, DCR = 0,
Configuration 1, ALPHA = 10, MACH = 0.6

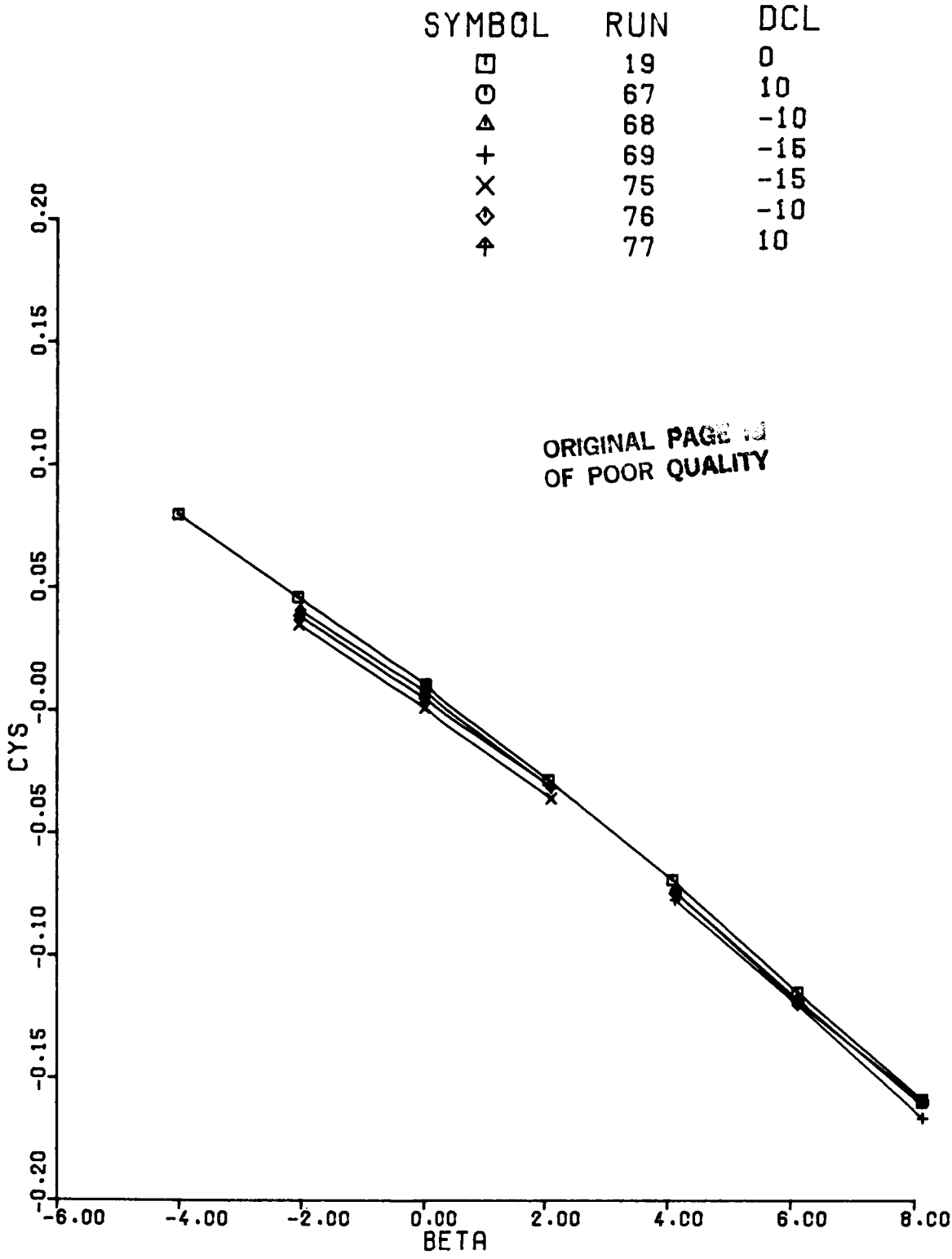

Figure 19(c). CYS vs BETA
Configuration 1, ALPHA = 10, MACH = 0.6

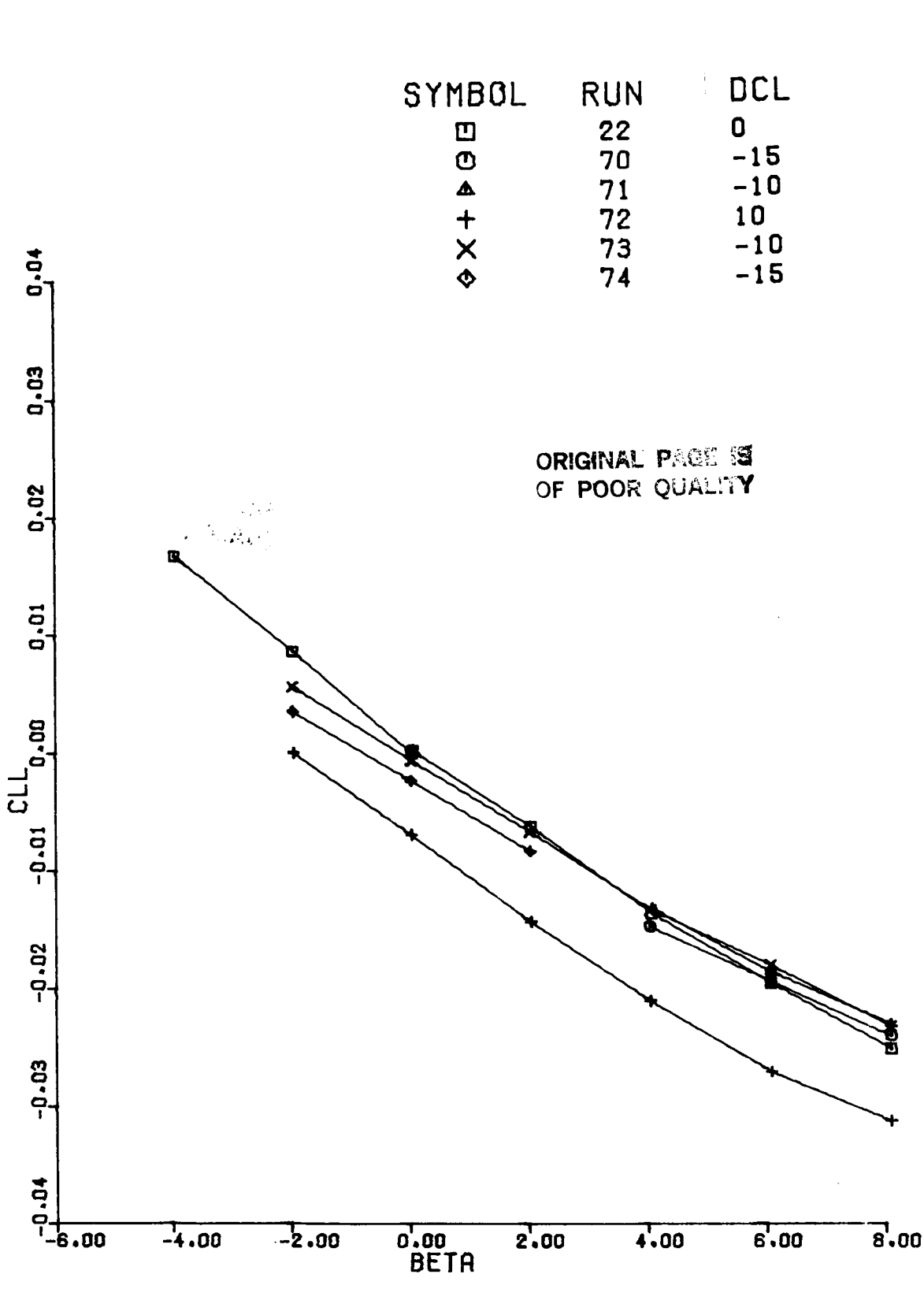

Figure 20(a). CLL vs BETA, DCR = 0,
Configuration 1, ALPHA = 15, MACH = 0.6

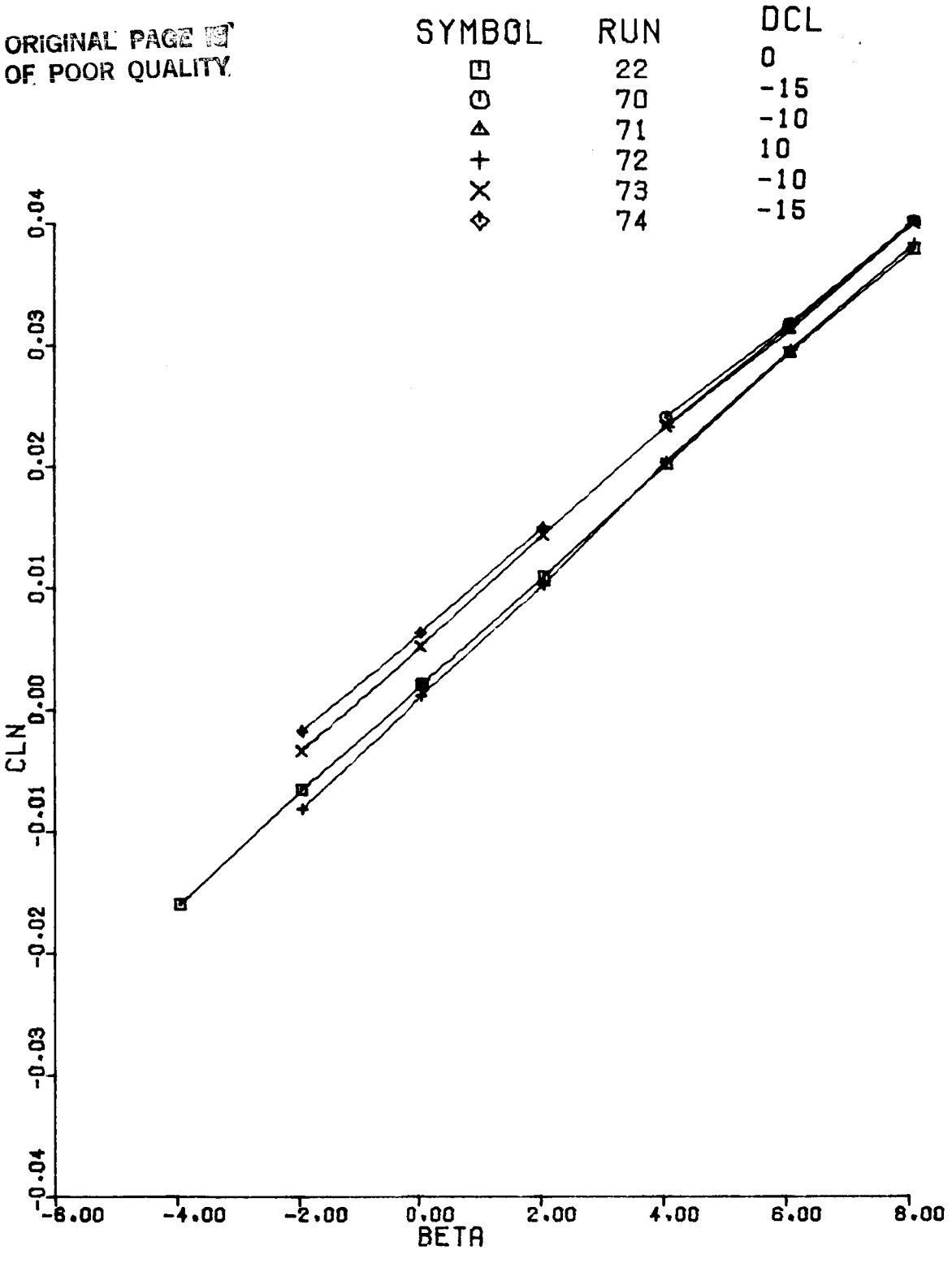

Figure 20(b). CLN vs BETA, DCR = 0,
Configuration 1, ALPHA = 15, MACH = 0.6

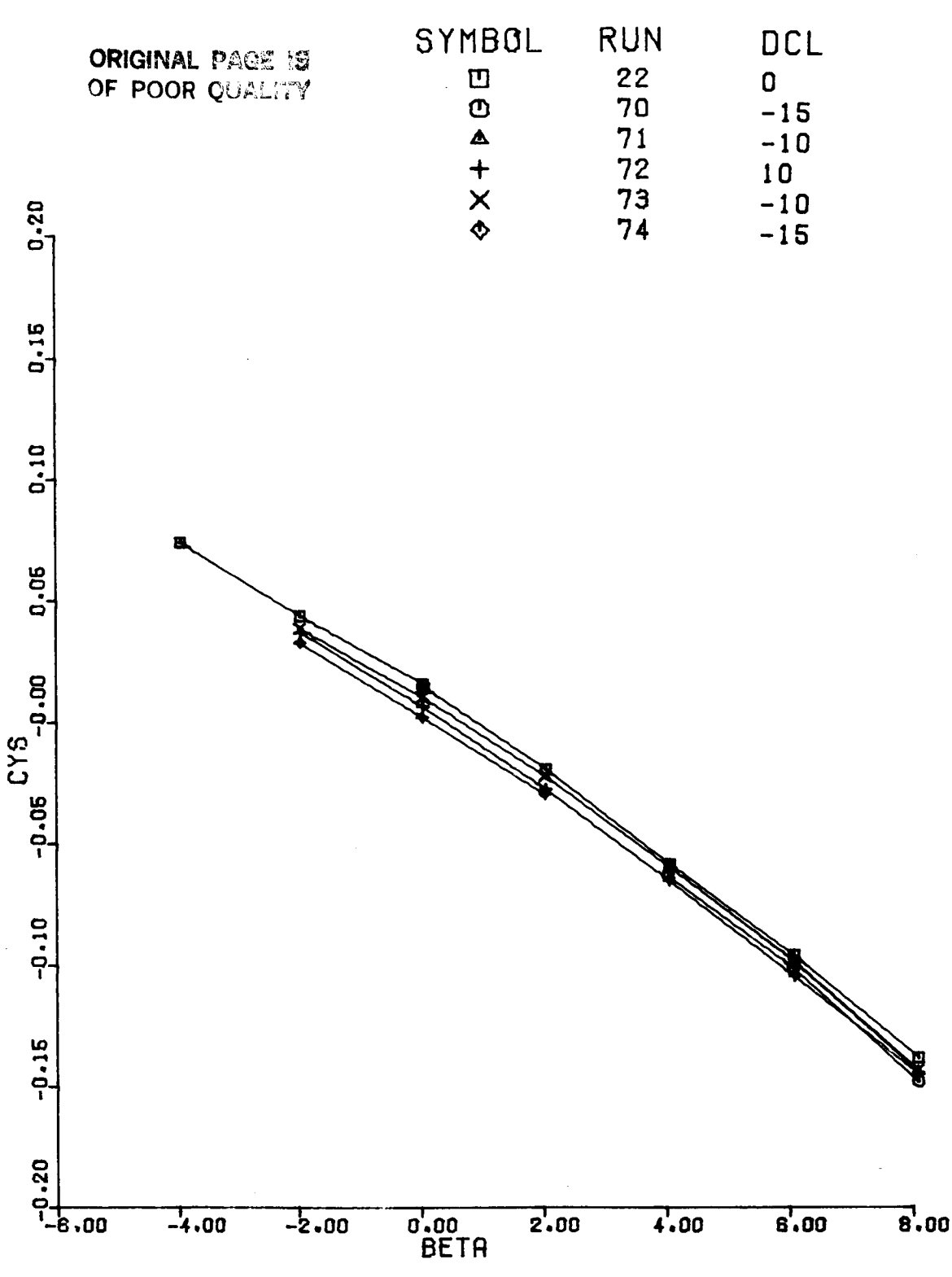

Figure 20(c). CYS vs BETA, DCR = 0,
Configuration 1, ALPHA = 15, MACH = 0.6

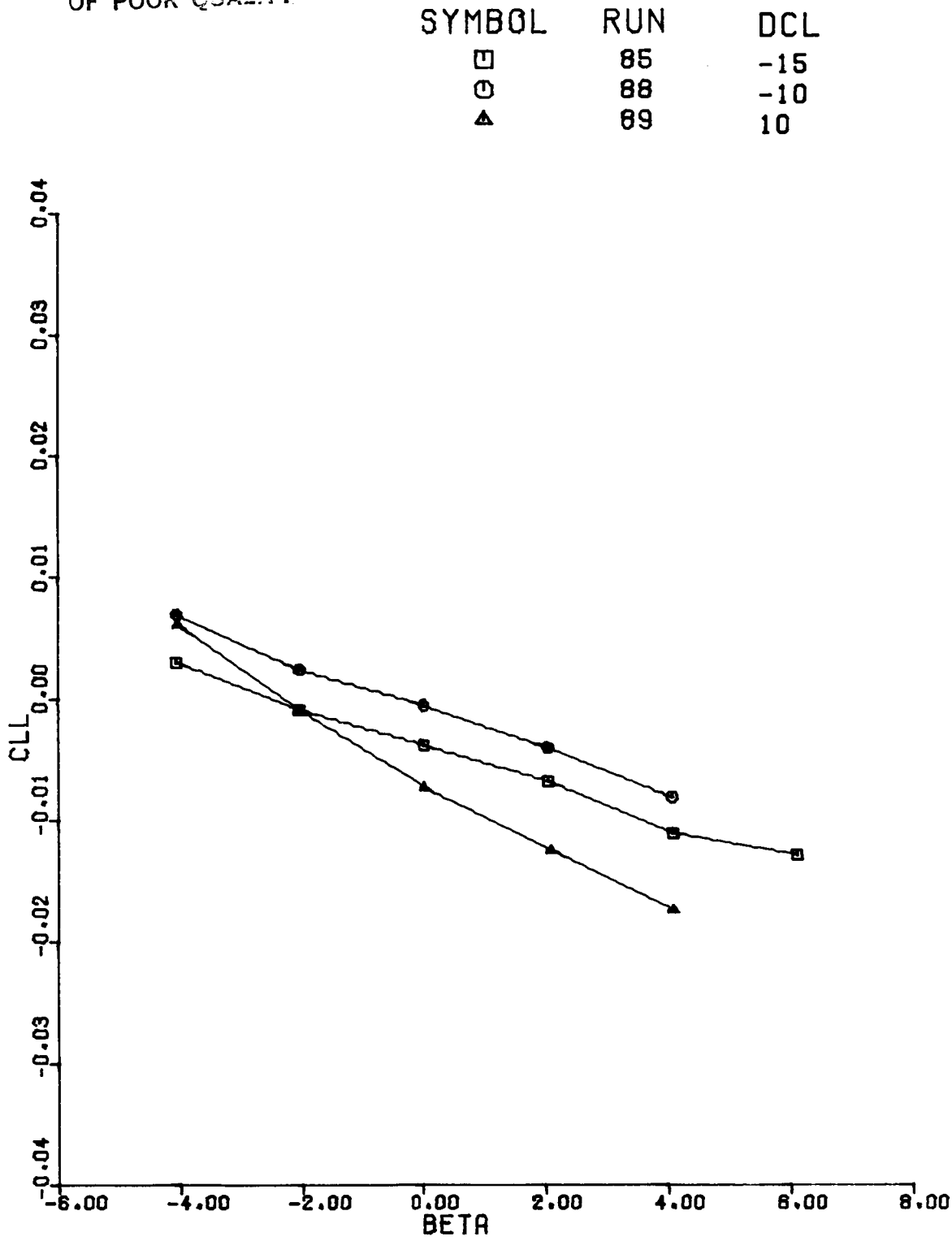

Figure 21(a). CLL vs BETA, DCR = 0,
Configuration 1, ALPHA = 10, MACH = 0.9

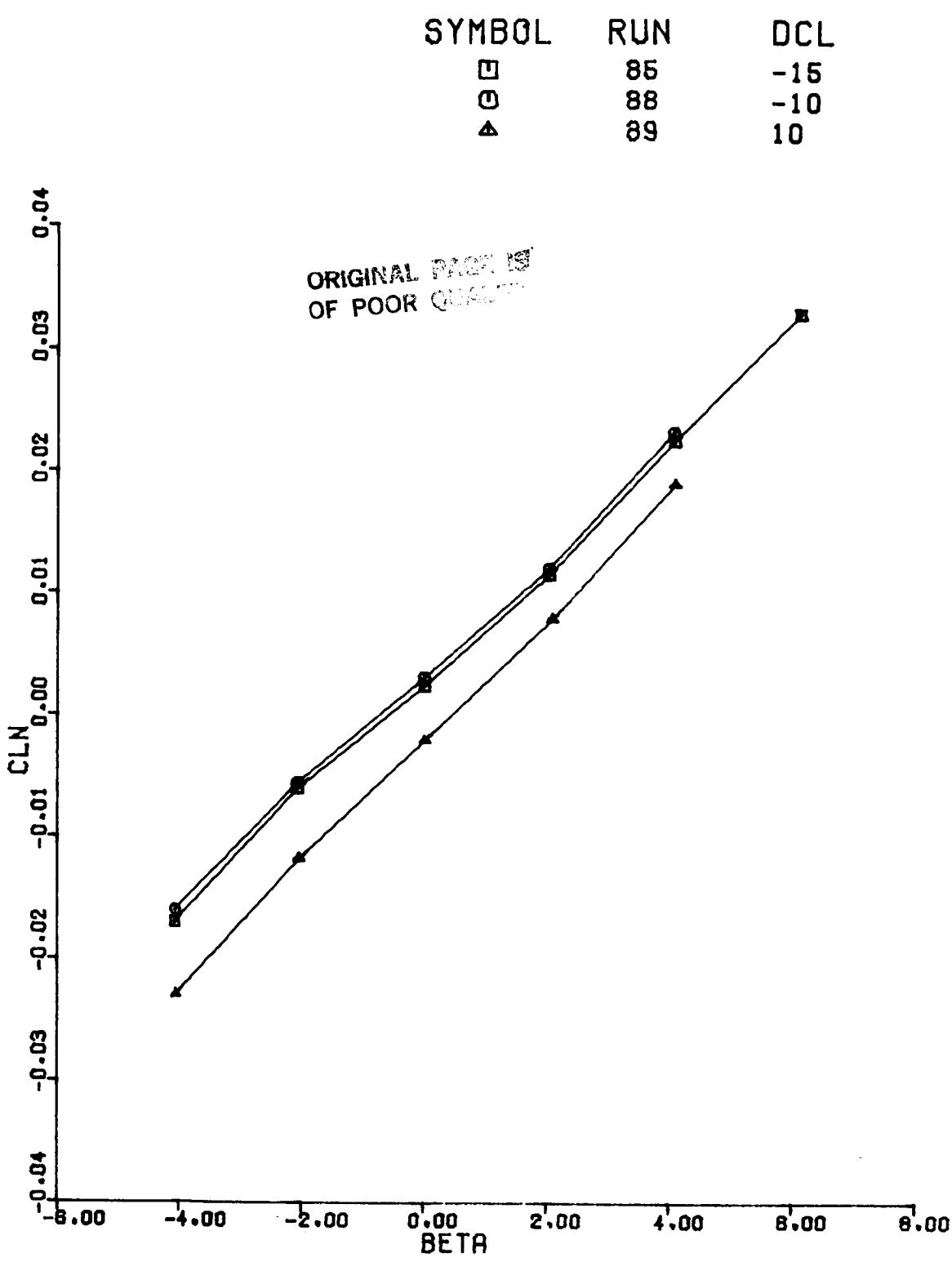

Figure 21(b). CLN vs BETA, DCR = 0, Configuration 1, ALPHA = 10, MACH = 0.9

SYMBOL	RUN	DCL
□	85	-15
○	88	-10
△	89	10

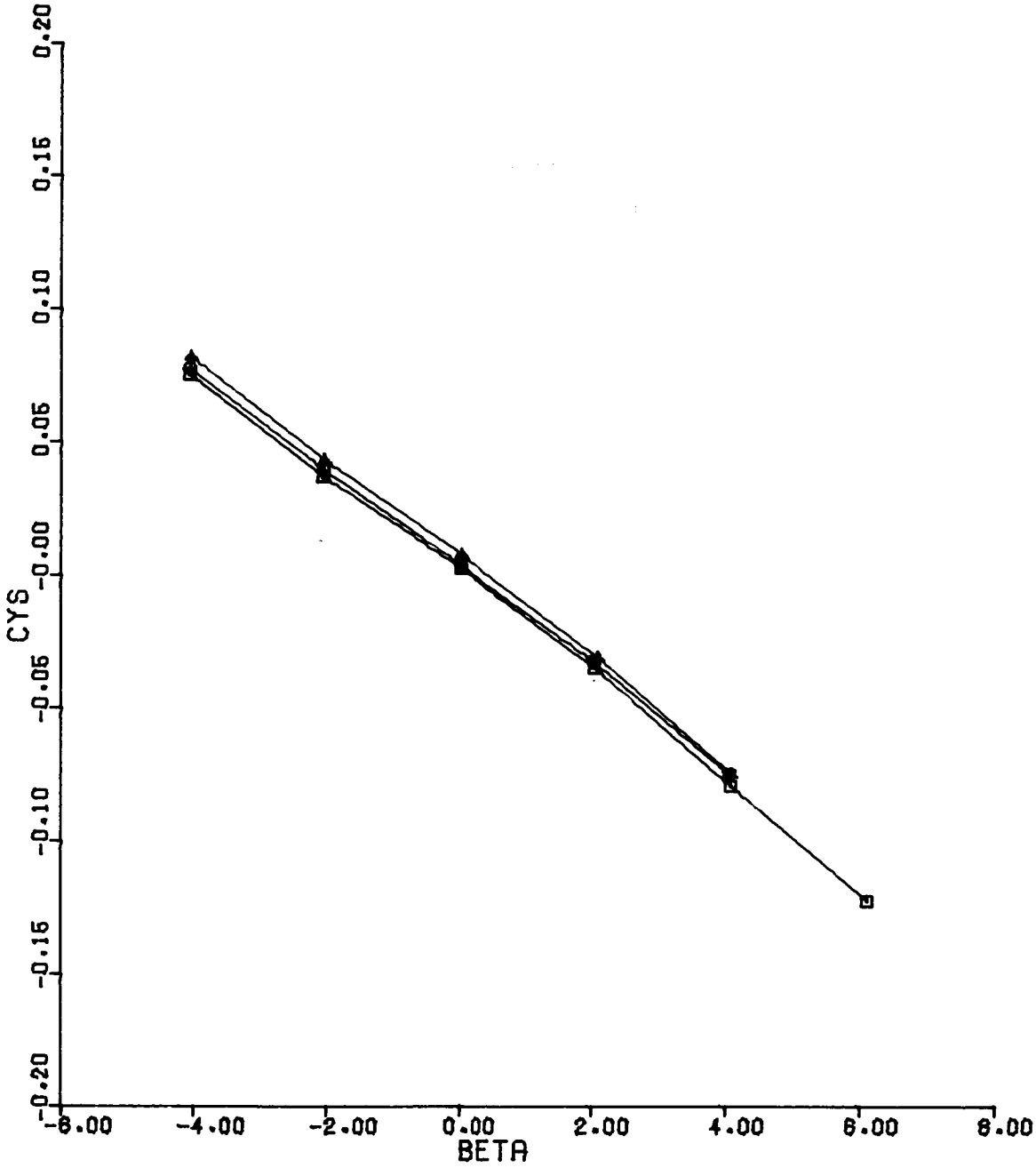

Figure 21(c). CYS vs BETA, DCR = 0,
Configuration 1, ALPHA = 10, MACH = 0.9

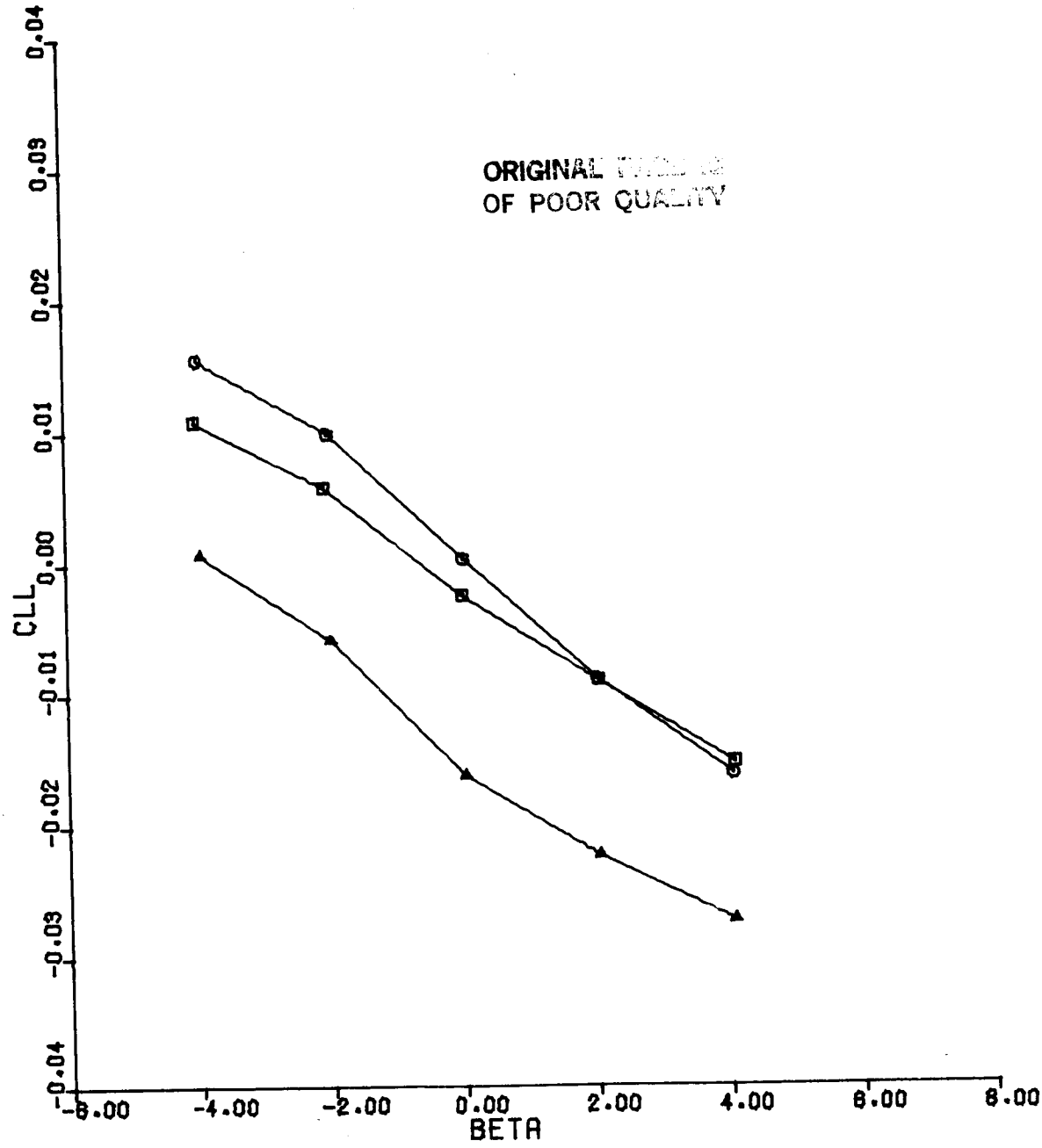

Figure 22(a). CLL vs BETA, DCR = 0, Configuration 1, ALPHA = 16, MACH = 0.9

SYMBOL	RUN	DCL
□	86	-15
○	87	-10
△	90	10

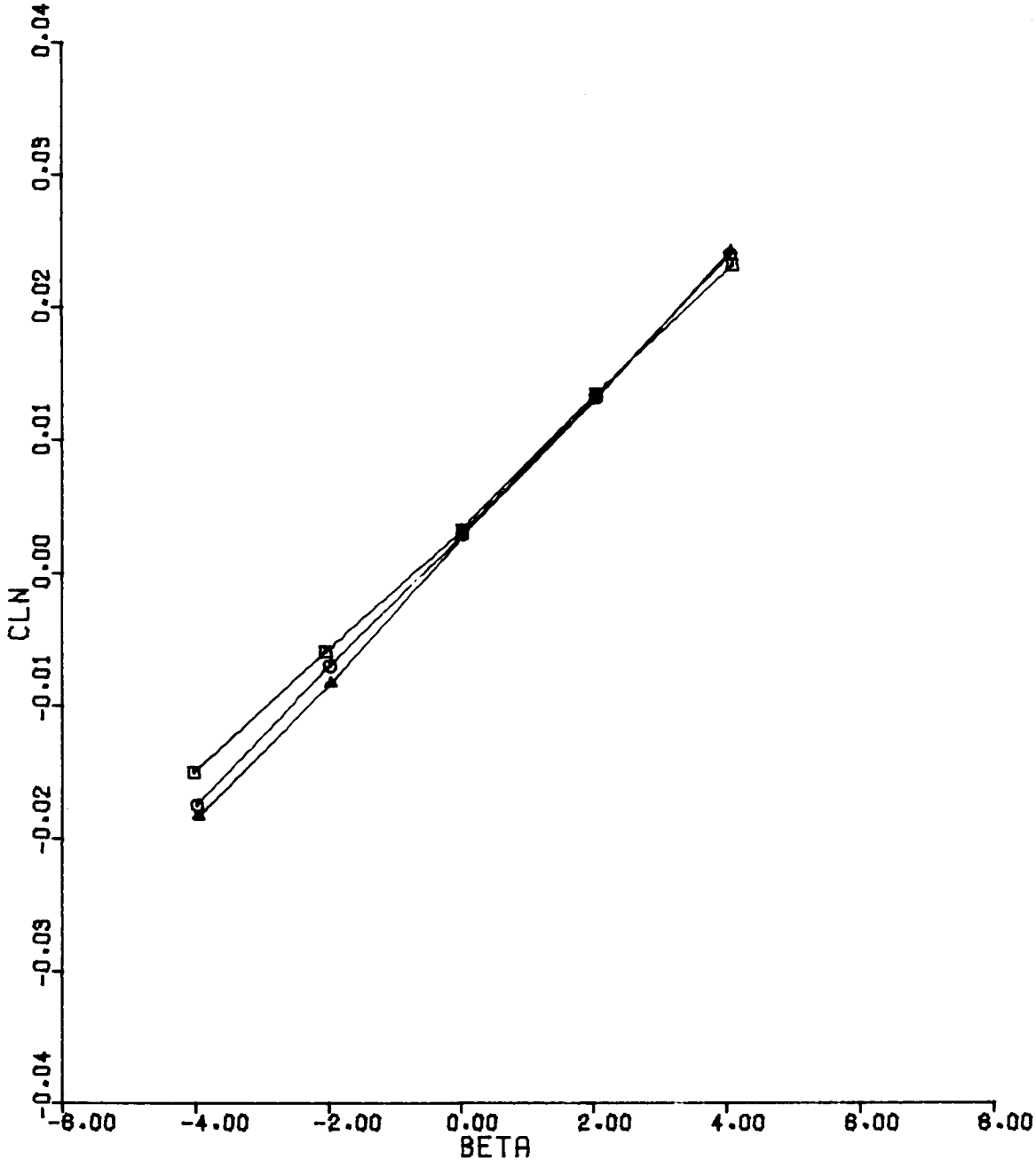

Figure 22(b). CLN vs BETA, DCR = 0,
Configuration 1, ALPHA = 16, MACH = 0.9

SYMBOL	RUN	DCL
□	86	-15
○	87	-10
△	90	10

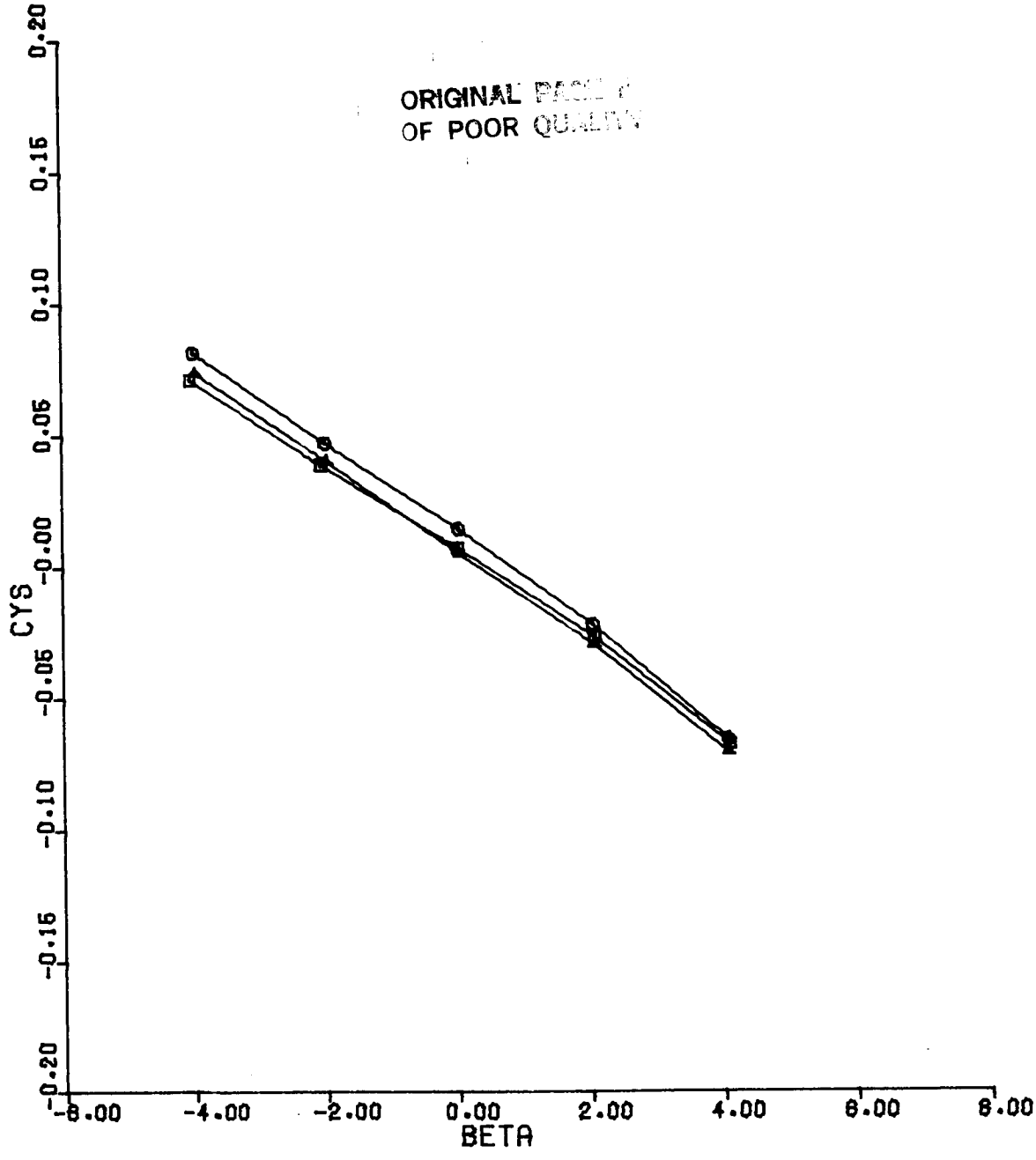

Figure 22(c). CYS vs BETA, DCR = 0,
Configuration 1, ALPHA = 16, MACH = 0.9

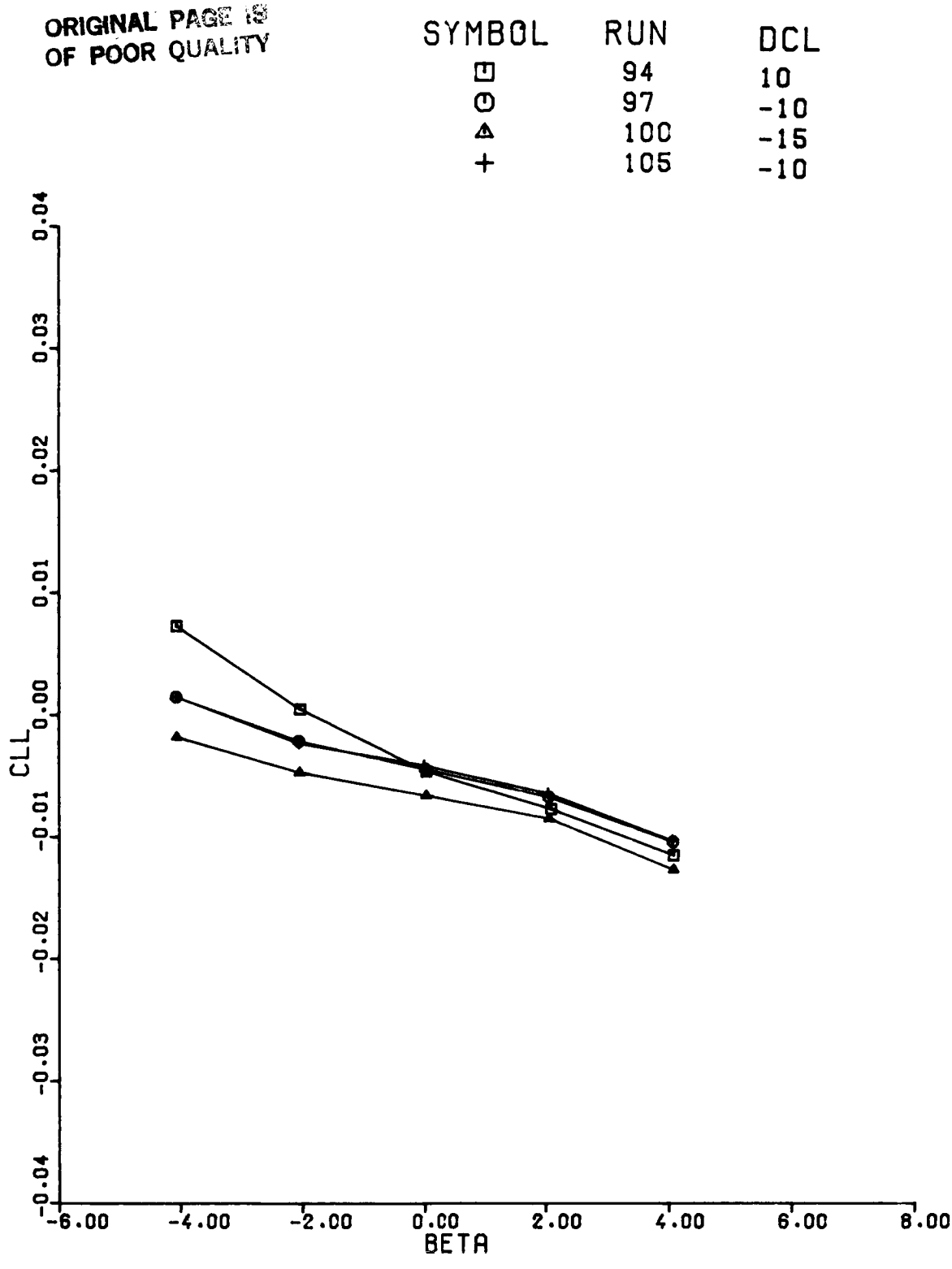

Figure 23(a). CLL vs BETA, DCR = 0,
Configuration 1, ALPHA = 11, MACH = 1.2

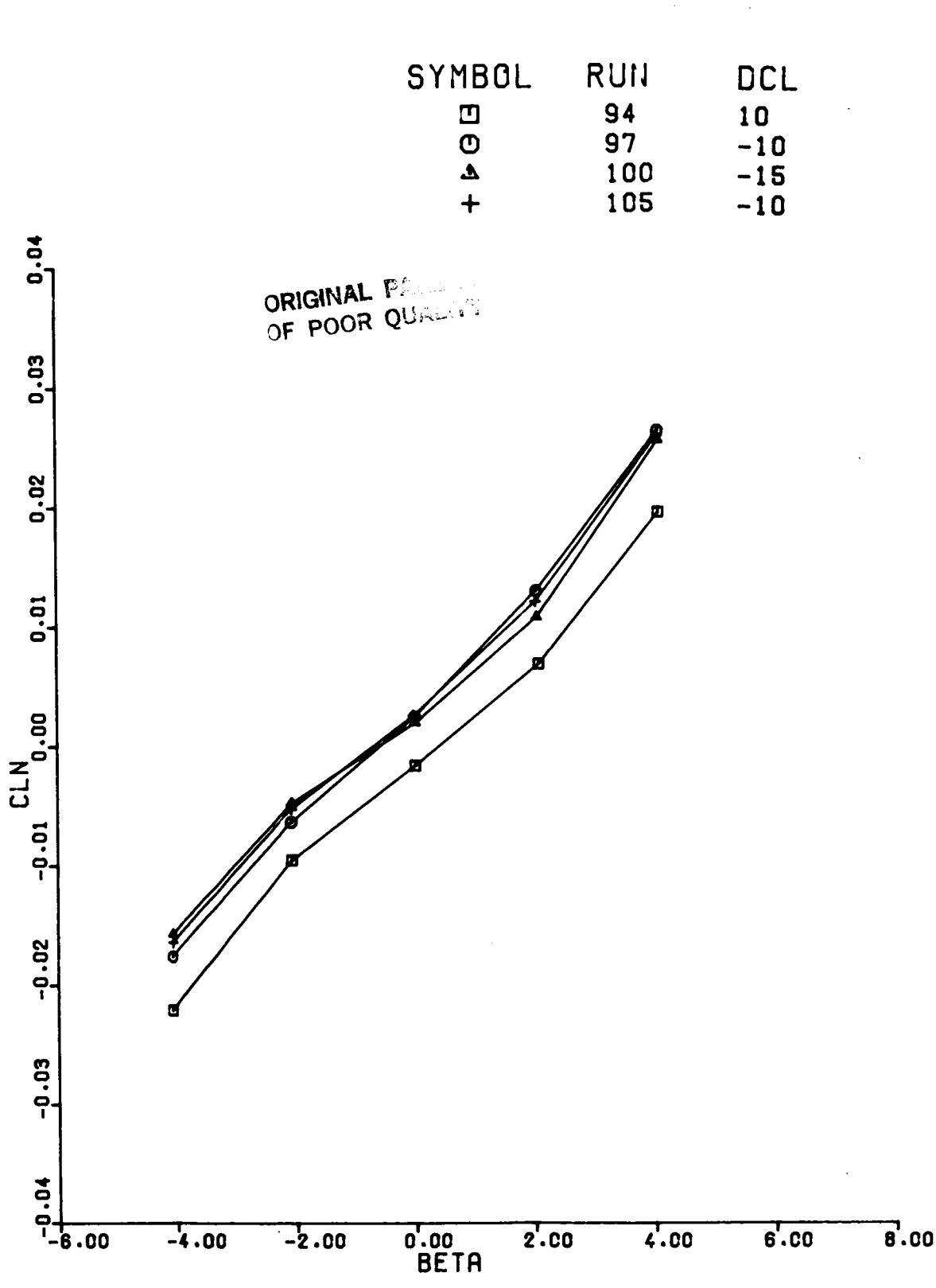

Figure 23(b). CLN vs BETA, DCR = 0, Configuration 1, ALPHA = 11, MACH = 1.2

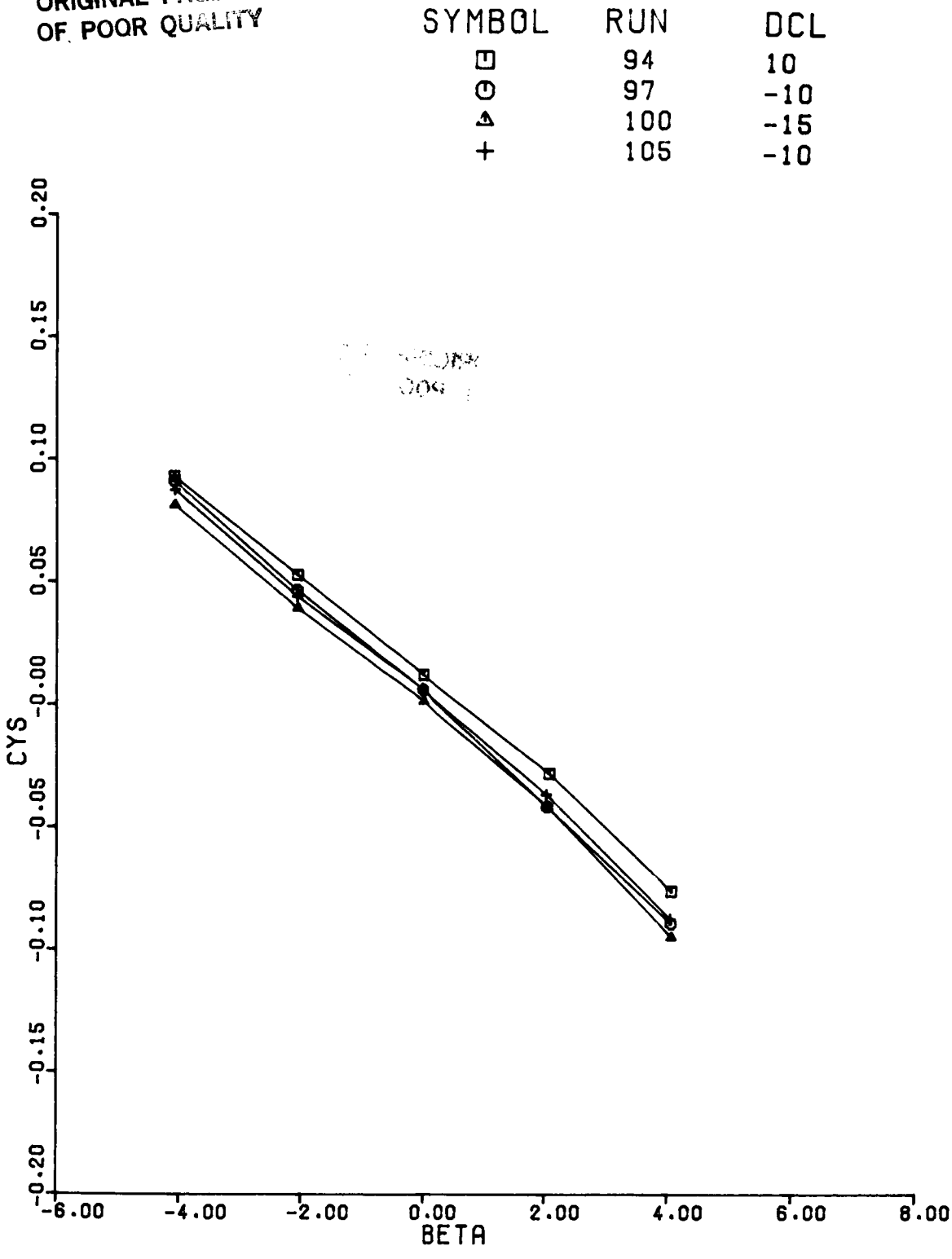

Figure 23(c). CYS vs BETA, DCR = 0,
Configuration 1, ALPHA = 11, MACH = 1.2

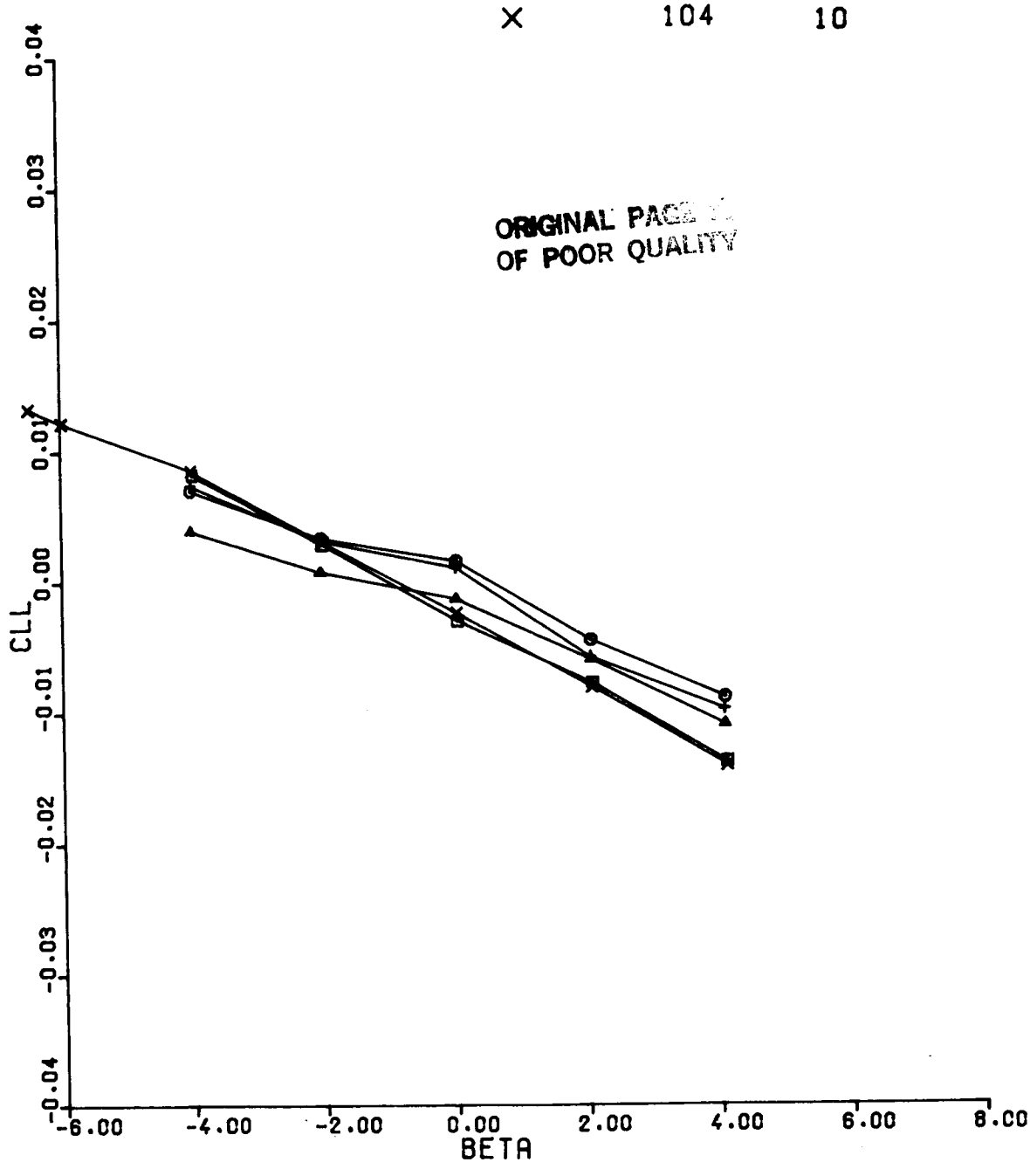

Figure 24(a). CLL vs BETA, DCR = 0, Configuration 1, ALPHA = 16, MACH = 1.2

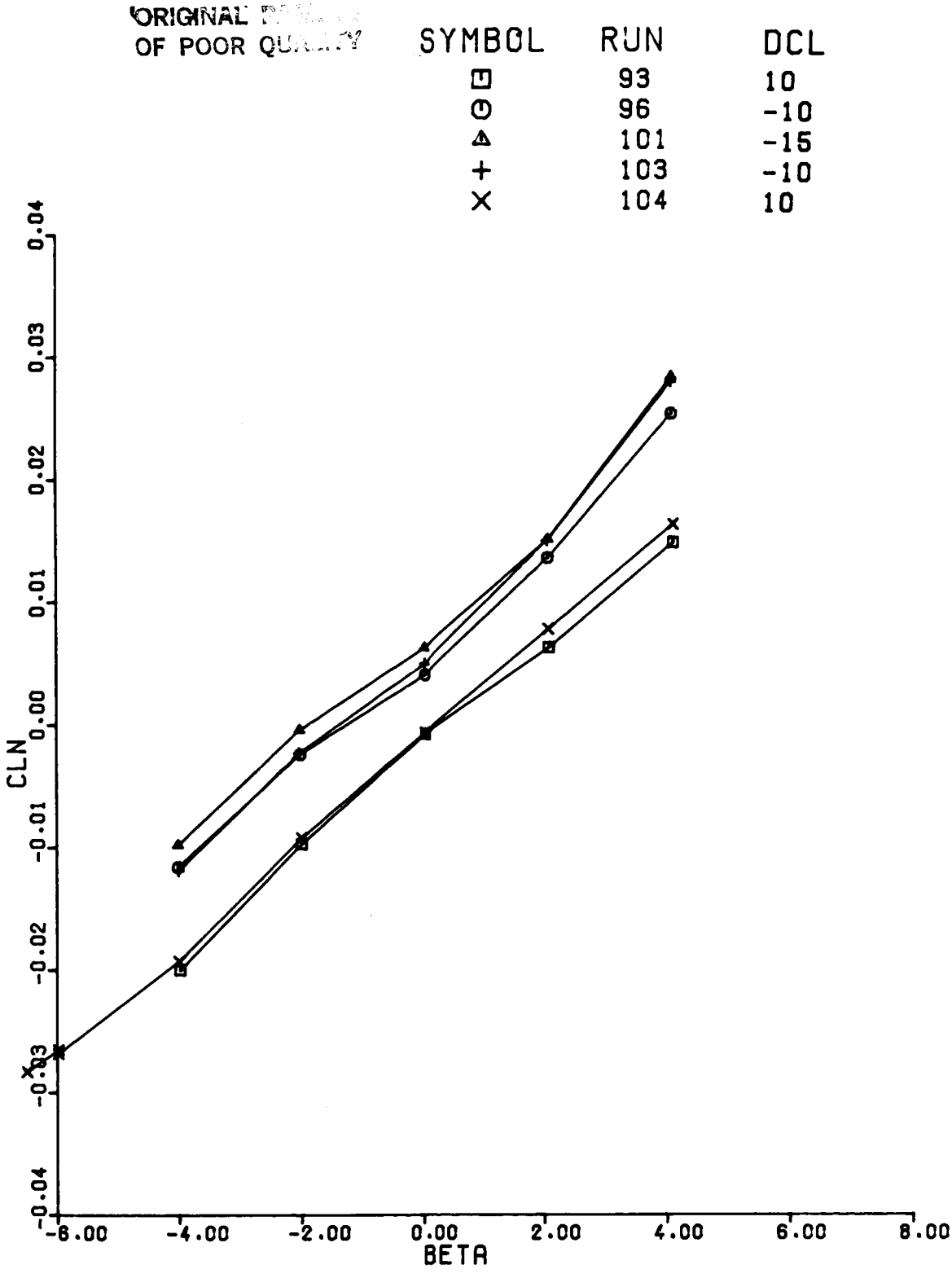

Figure 24(b). CLN vs BETA, DCR = 0,
Configuration 1, ALPHA = 16, MACH = 1.2

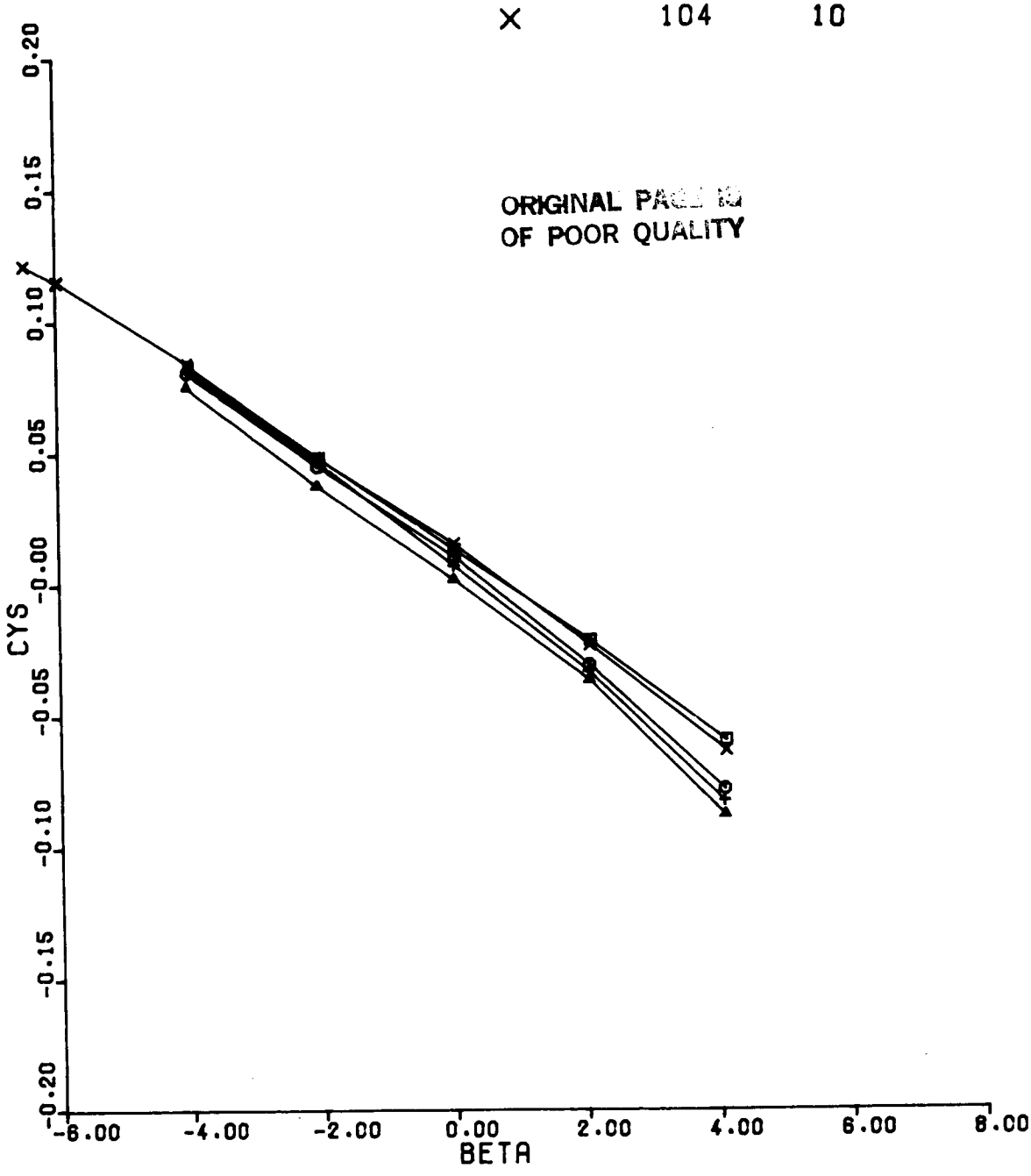

Figure 24(c). CYS vs BETA, DCR = 0,
Configuration 1, ALPHA = 16, MACH = 1.2

SYMBOL	RUN	ALPHA
□	30	18
○	31	21

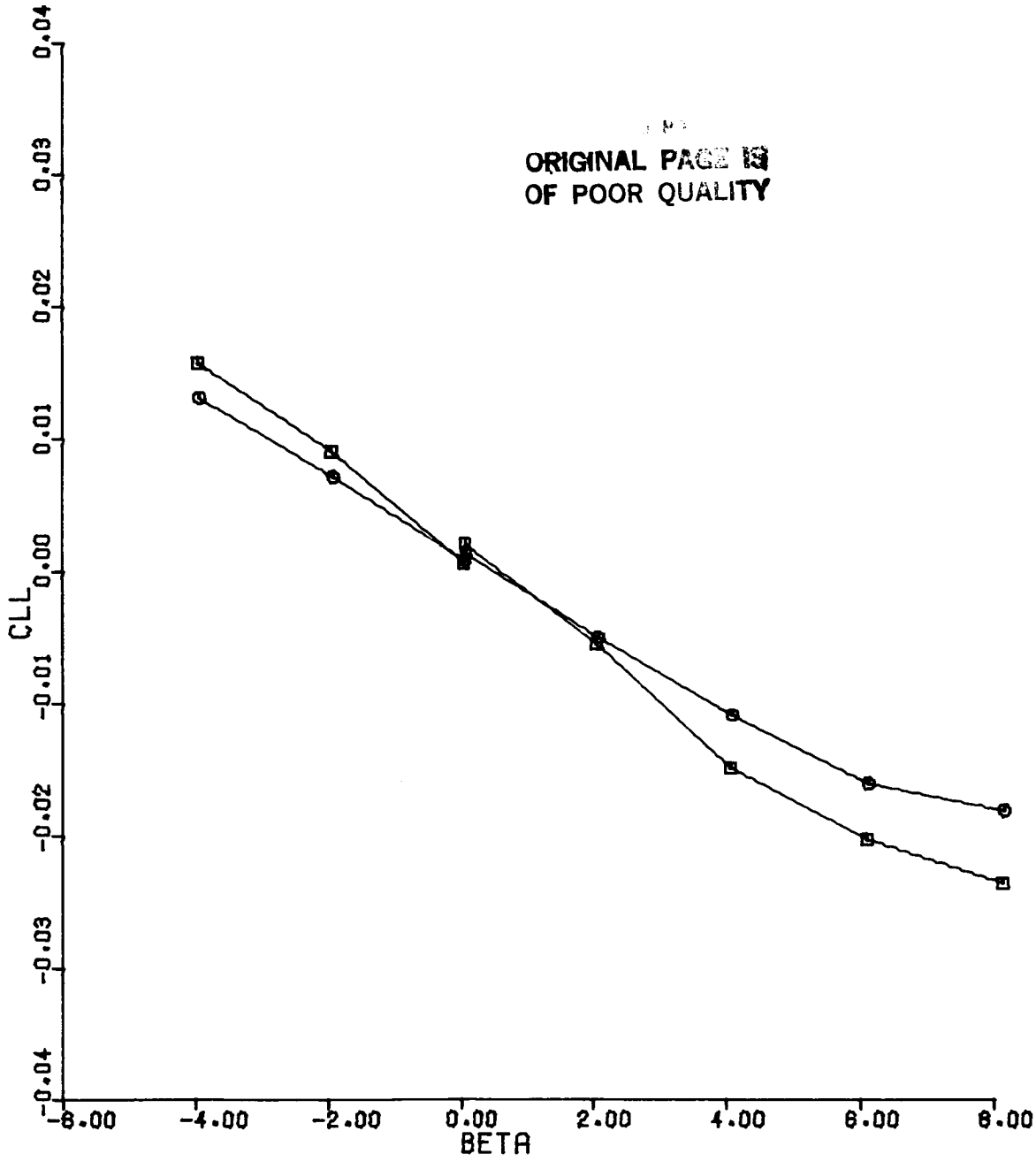

Figure 25(a). CLL vs BETA
Configuration 1, MACH = 0.9, DC = 0

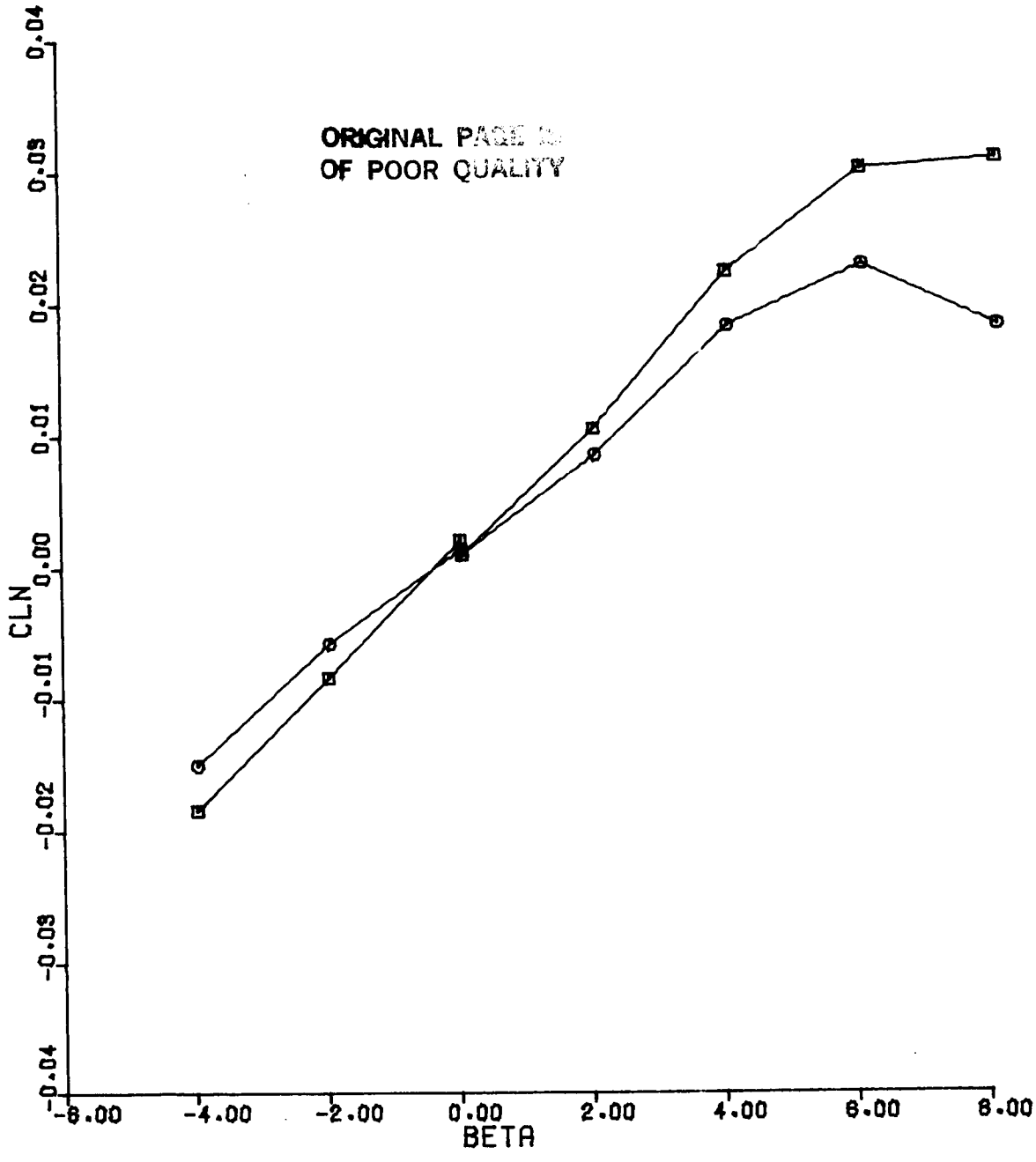

Figure 25(b). CLN vs BETA
Configuration 1, MACH = 0.9, DC = 0

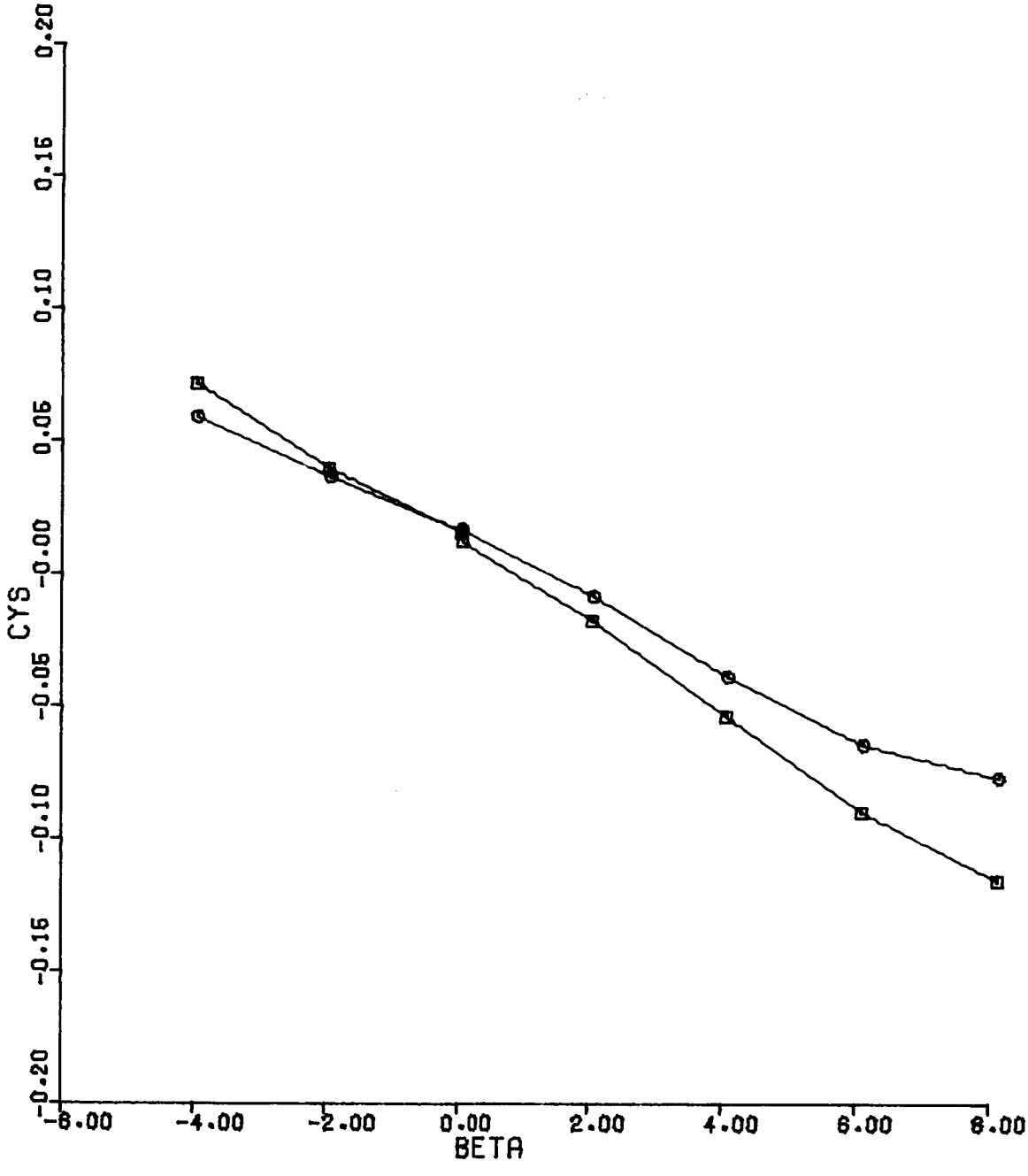

Figure 25(c). CYS vs BETA
Configuration 1, MACH = 0.9, DC = 0

SYMBOL	RUN	DC
□	107	-10
○	108	0
△	109	10

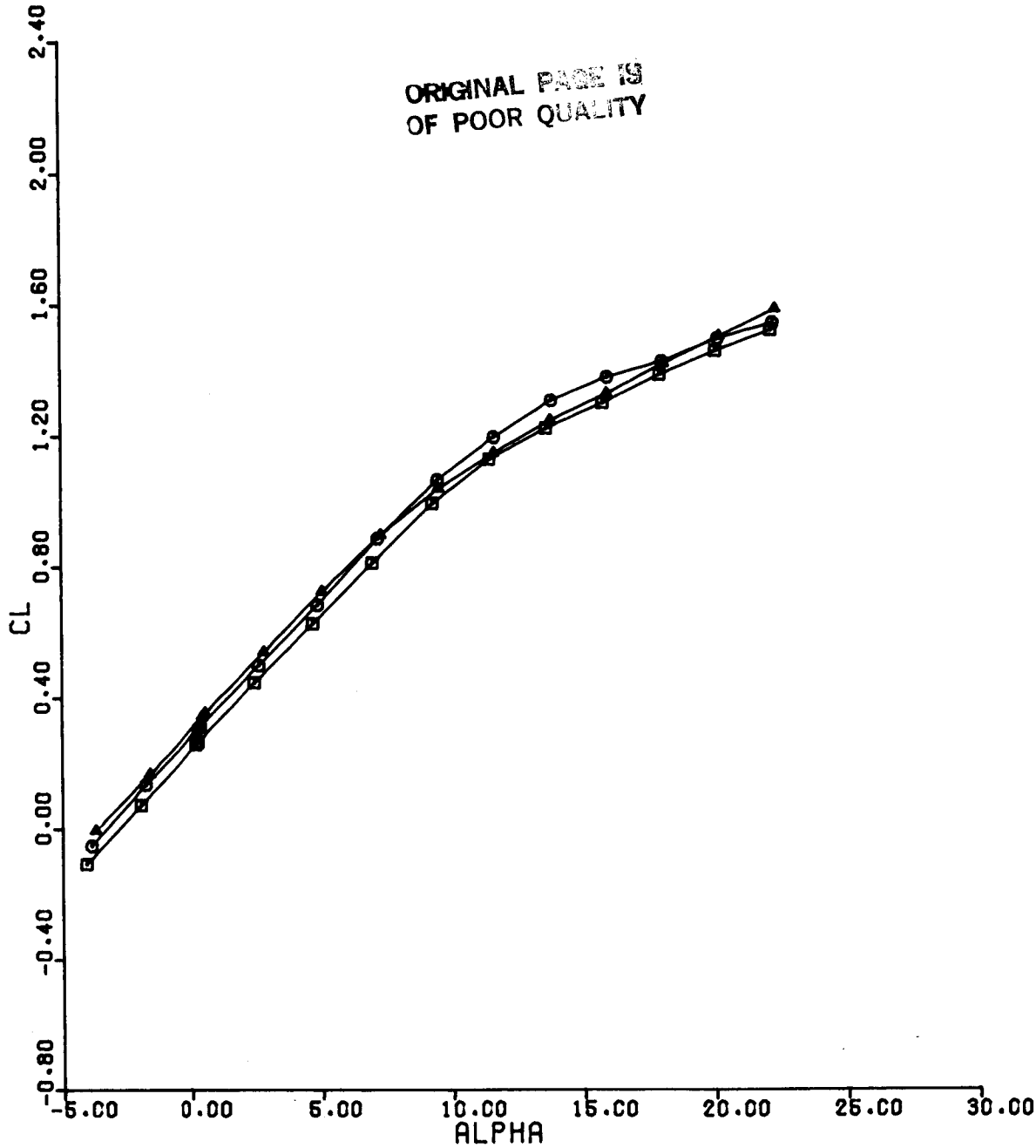

Figure 26(a). CL vs ALPHA, DS = 0,
Configuration 2, BETA = 0, MACH = 0.6

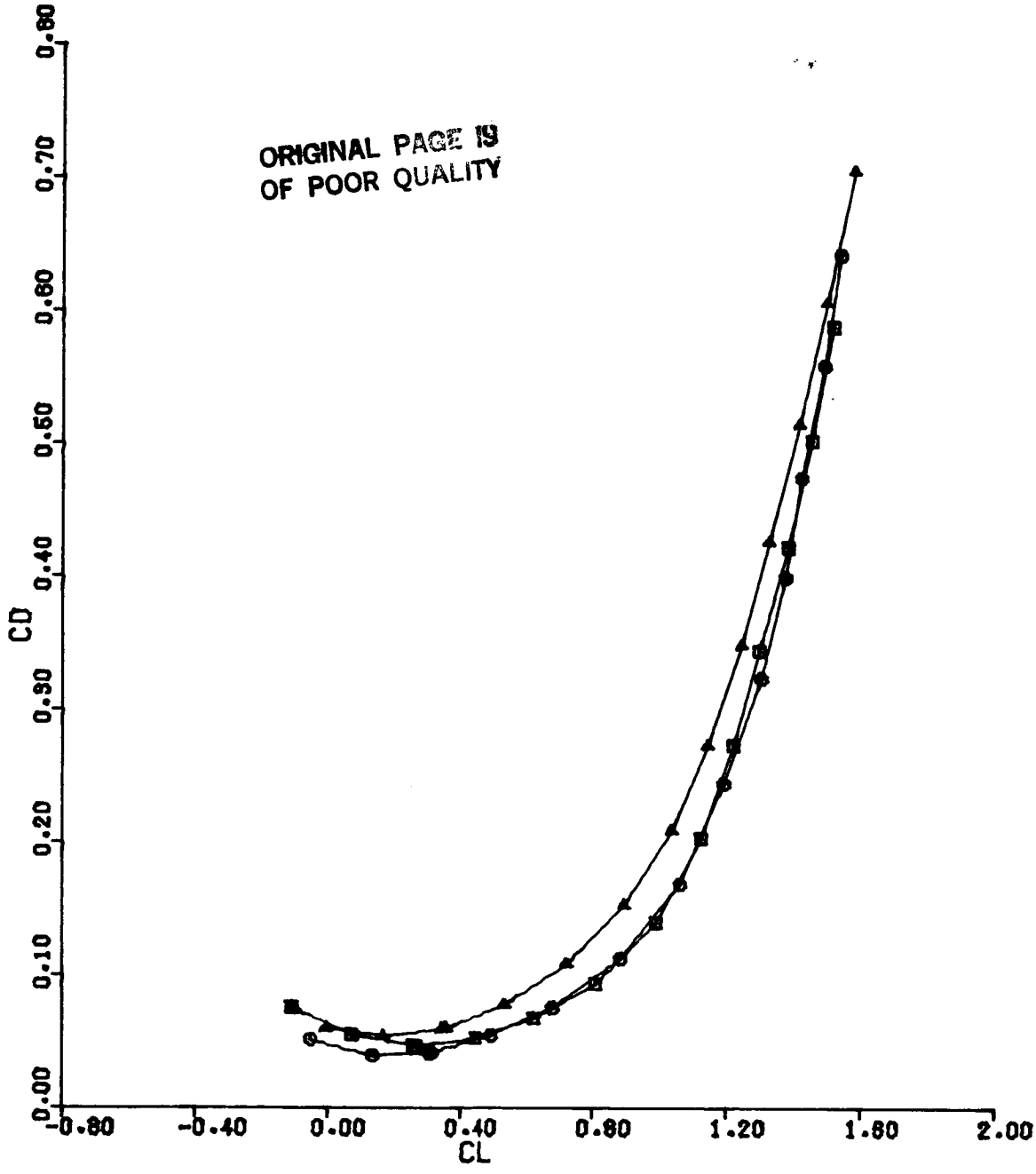

Figure 26(b). CD vs CL, DS = 0,
Configuration 2, BETA = 0, MACH = 0.6

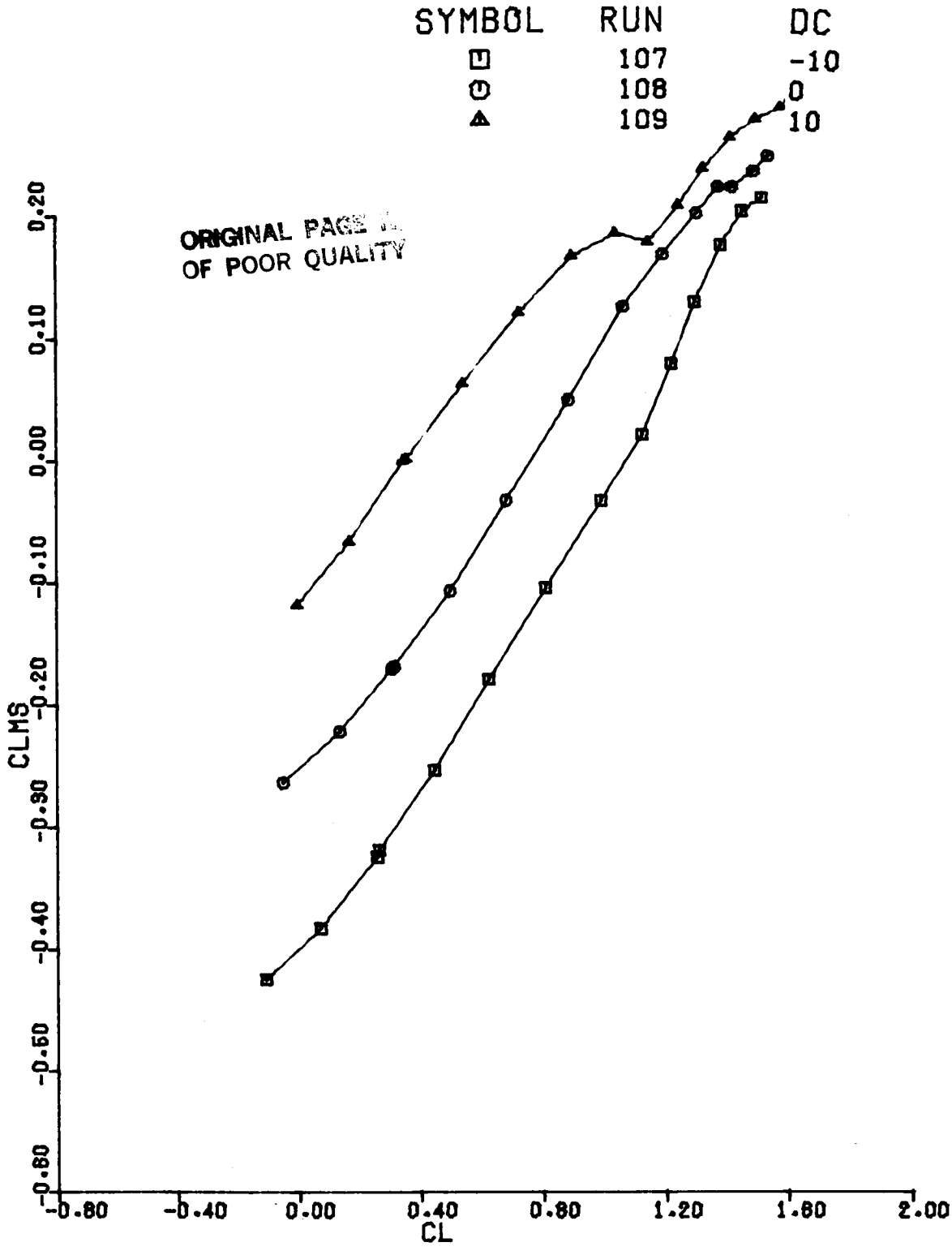

Figure 26(c). CLMS vs CL, DS = 0,
Configuration 2, BETA = 0, MACH = 0.6

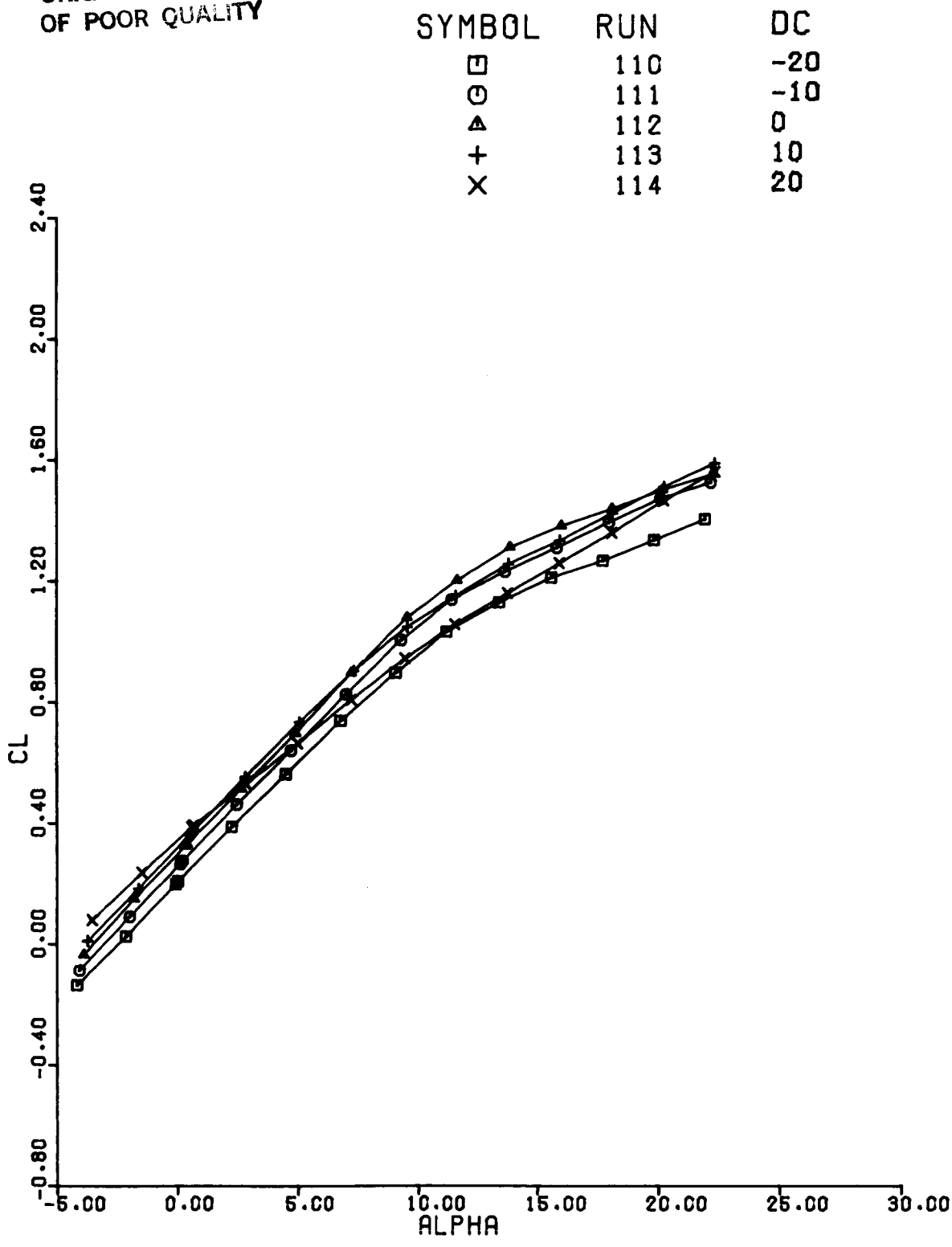

Figure 27(a). CL vs ALPHA, DS = 5,
Configuration 2, BETA = 0, MACH = 0.6

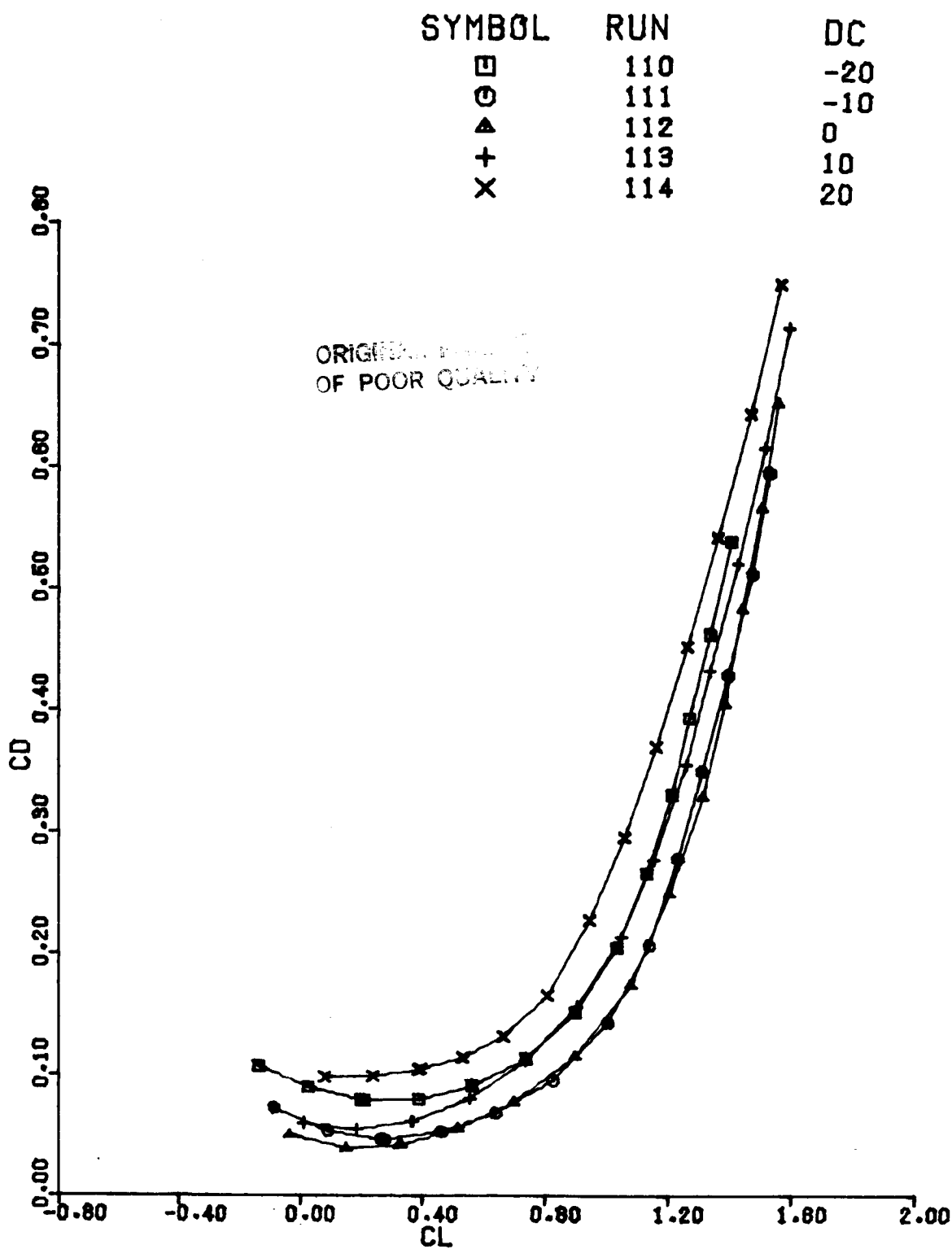

Figure 27(b). CD vs CL, DS = 5, Configuration 2, BETA = 0, MACH = 0.6

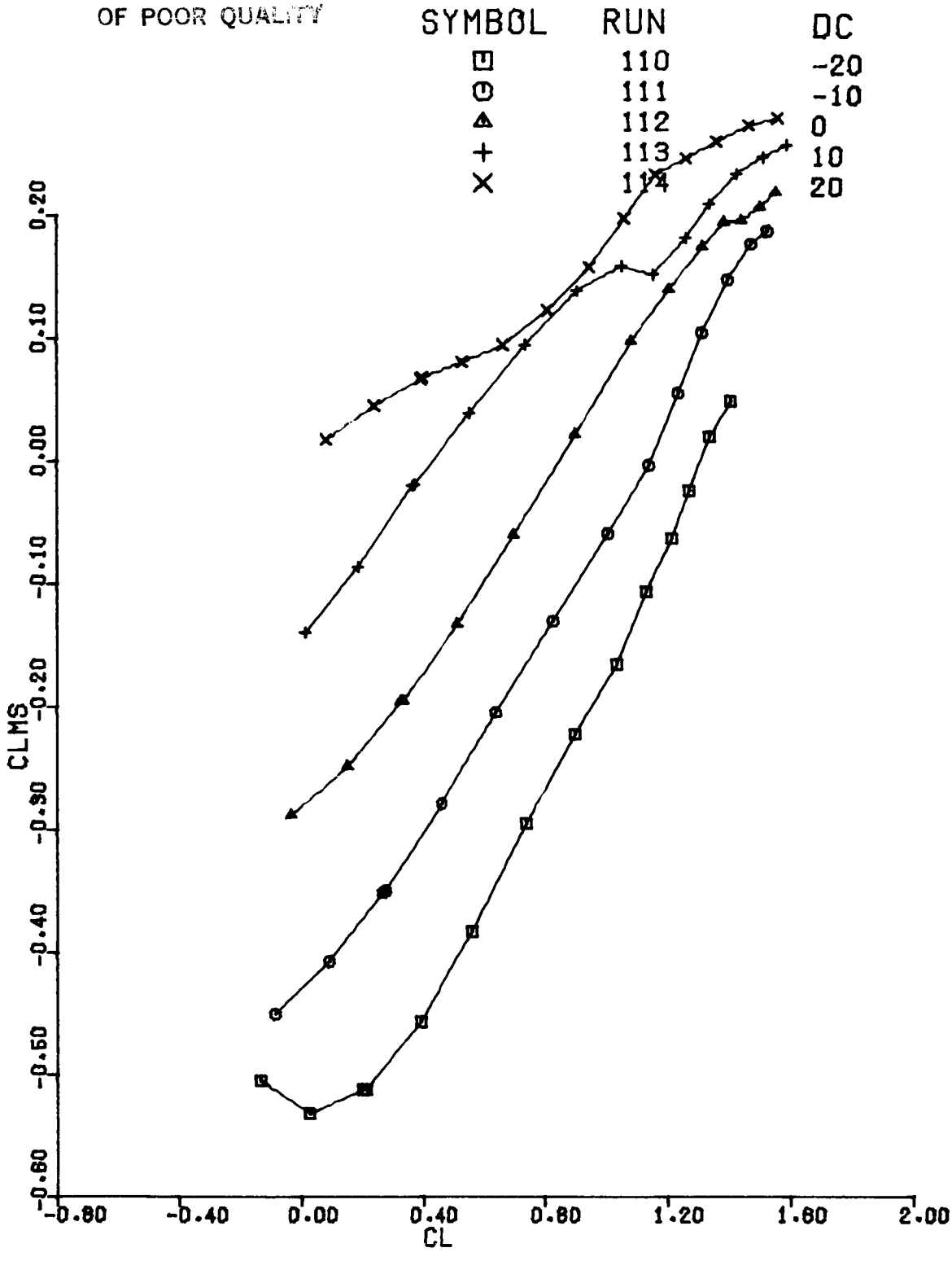

Figure 27(c). CLMS vs CL, DS = 5,
Configuration 2, BETA = 0, MACH = 0.6

SYMBOL	RUN	DC
⊡	115	20
⊙	116	10
△	117	0
+	118	-10
×	119	-20

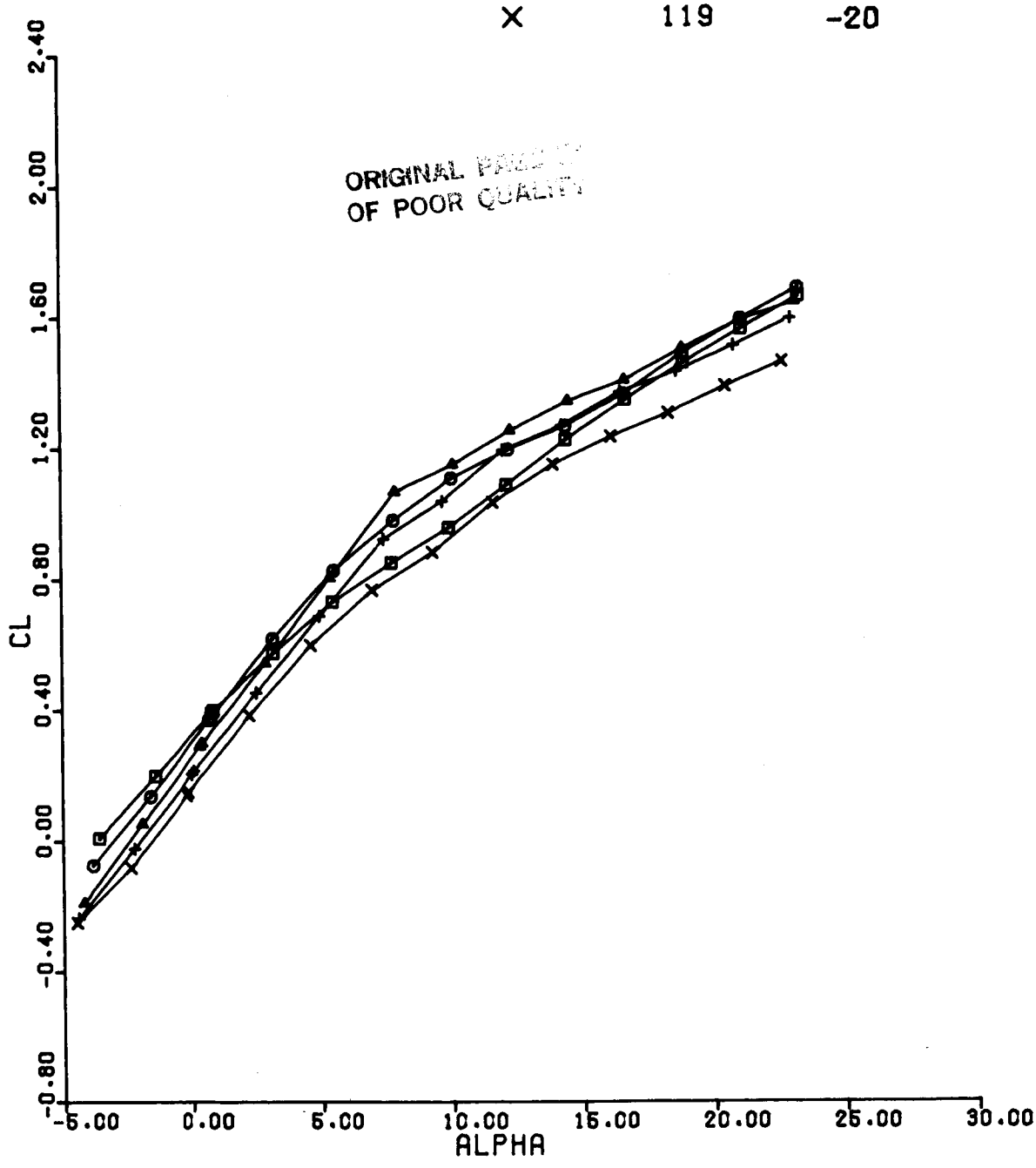

Figure 28(a). CL vs ALPHA, DS = 5,
Configuration 2, BETA = 0, MACH = 0.9

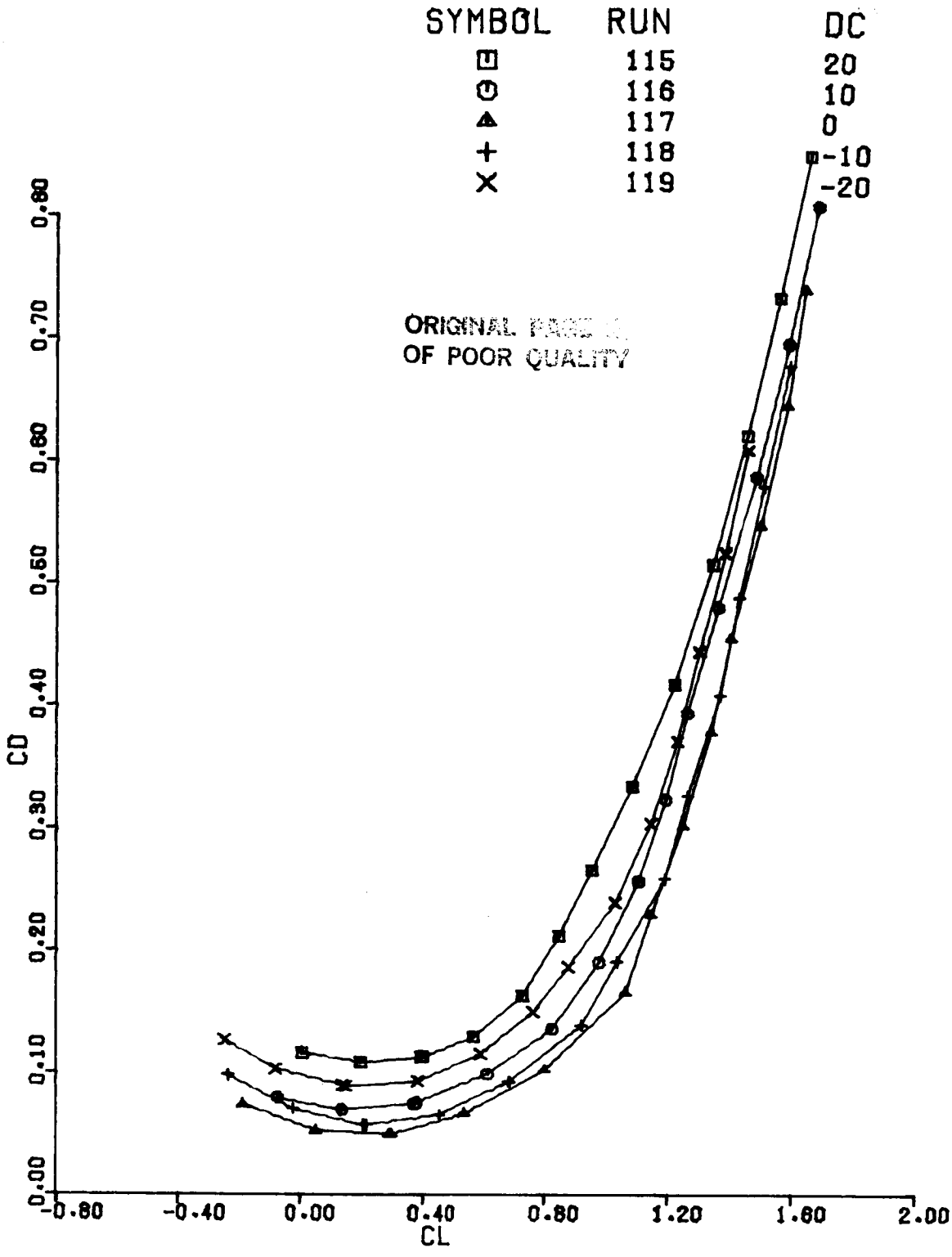

Figure 28(b). CD vs CL, DS = 5,
Configuration 2, BETA = 0, MACH = 0.9

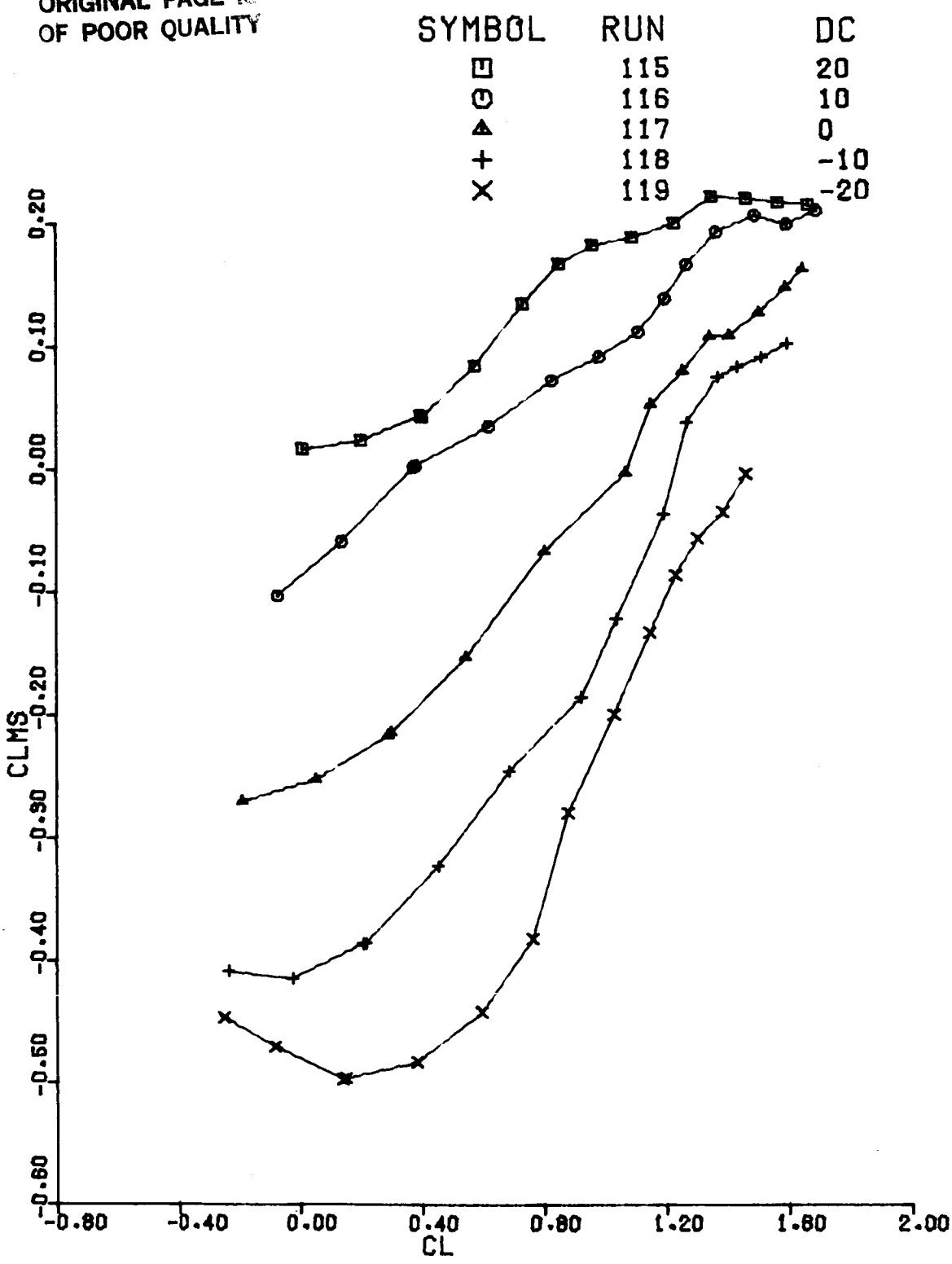

Figure 28(c). CLMS vs CL, DS = 5, Configuration 2, BETA = 0, MACH = 0.9

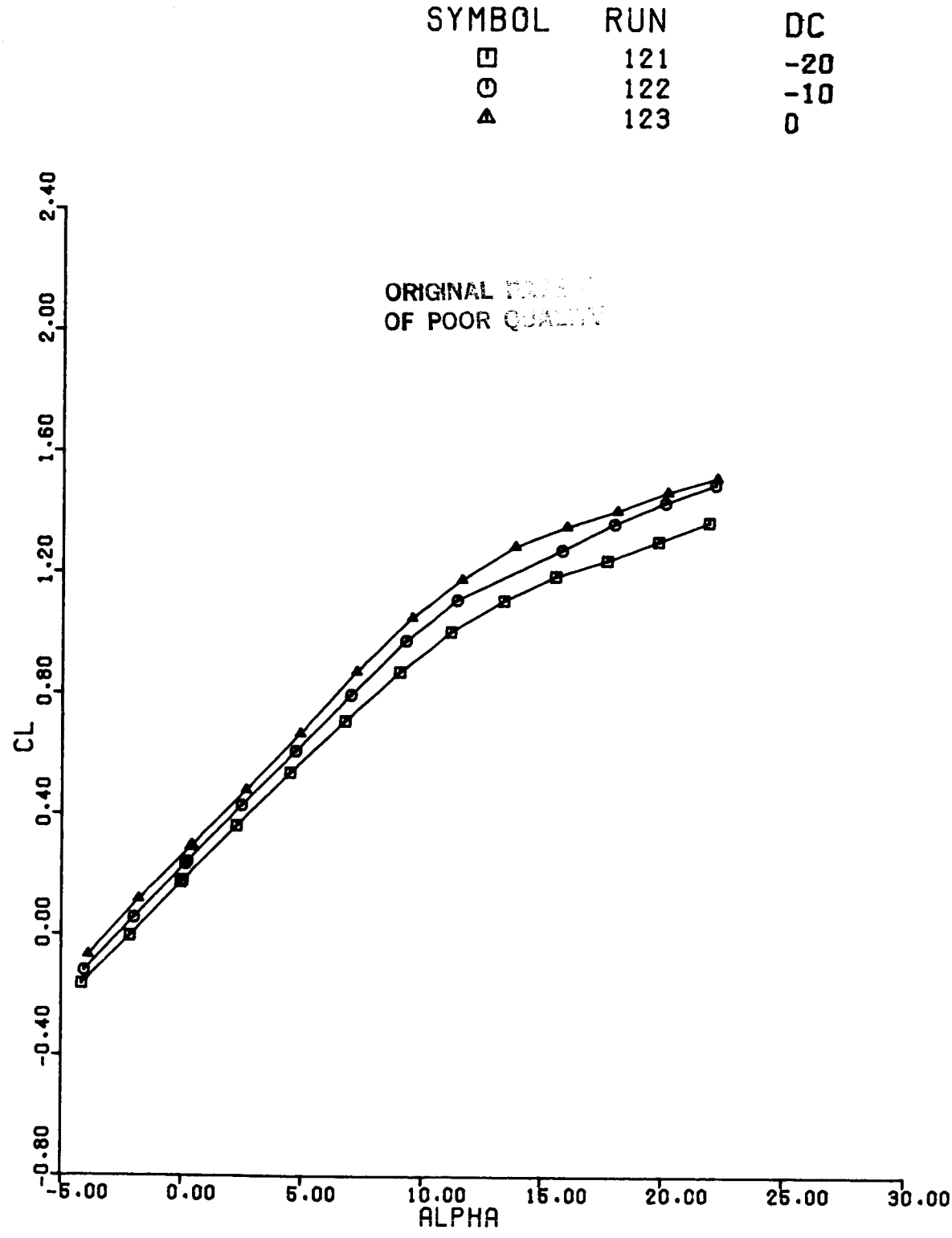

Figure 29(a). CL vs ALPHA, DS = -5,
Configuration 2, BETA = 0, MACH = 0.6

SYMBOL	RUN	DC
□	121	-20
○	122	-10
△	123	0

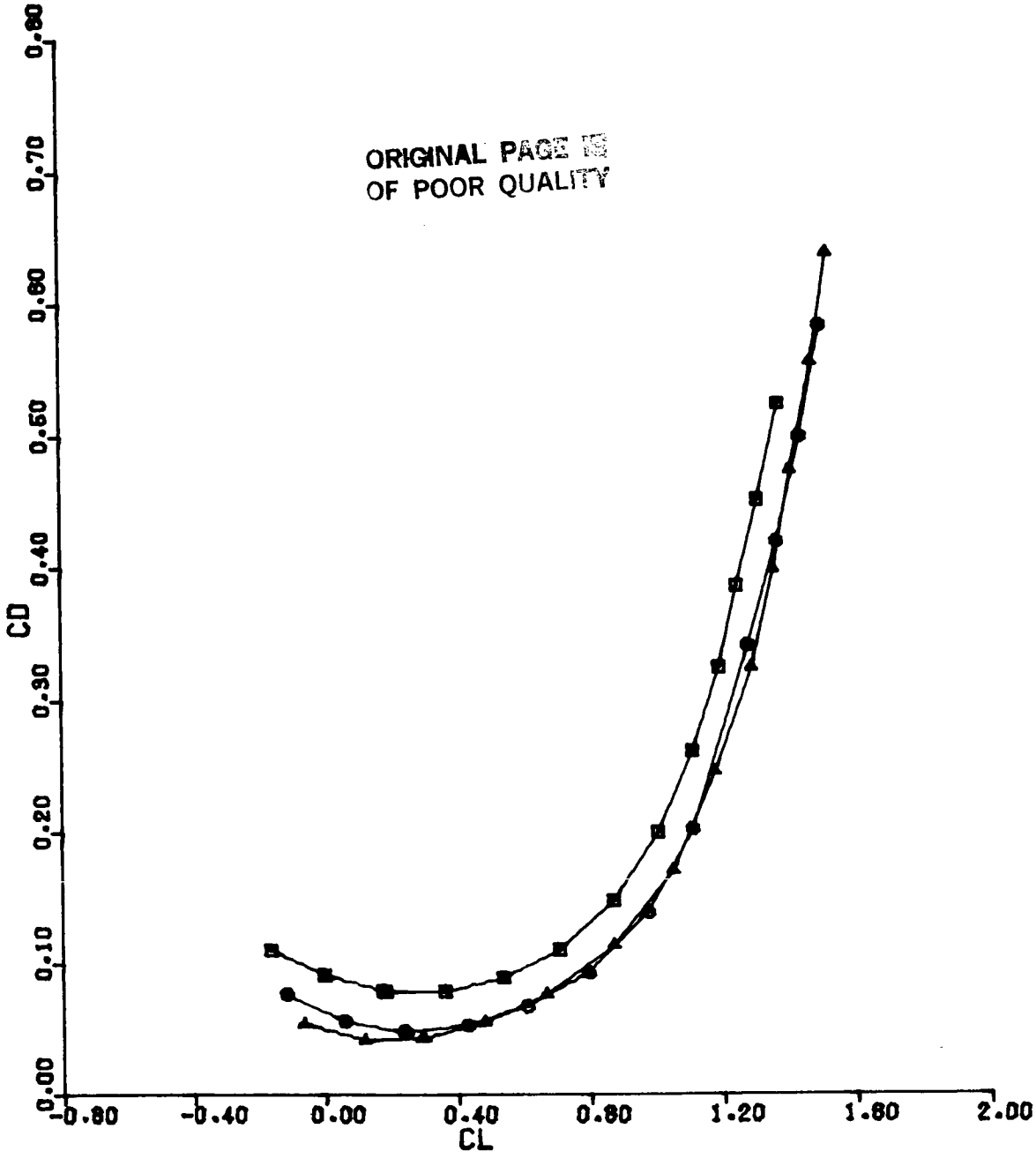

Figure 29(b). CD vs CL, DS = -5,
Configuration 2, BETA = 0, MACH = 0.6

C-2

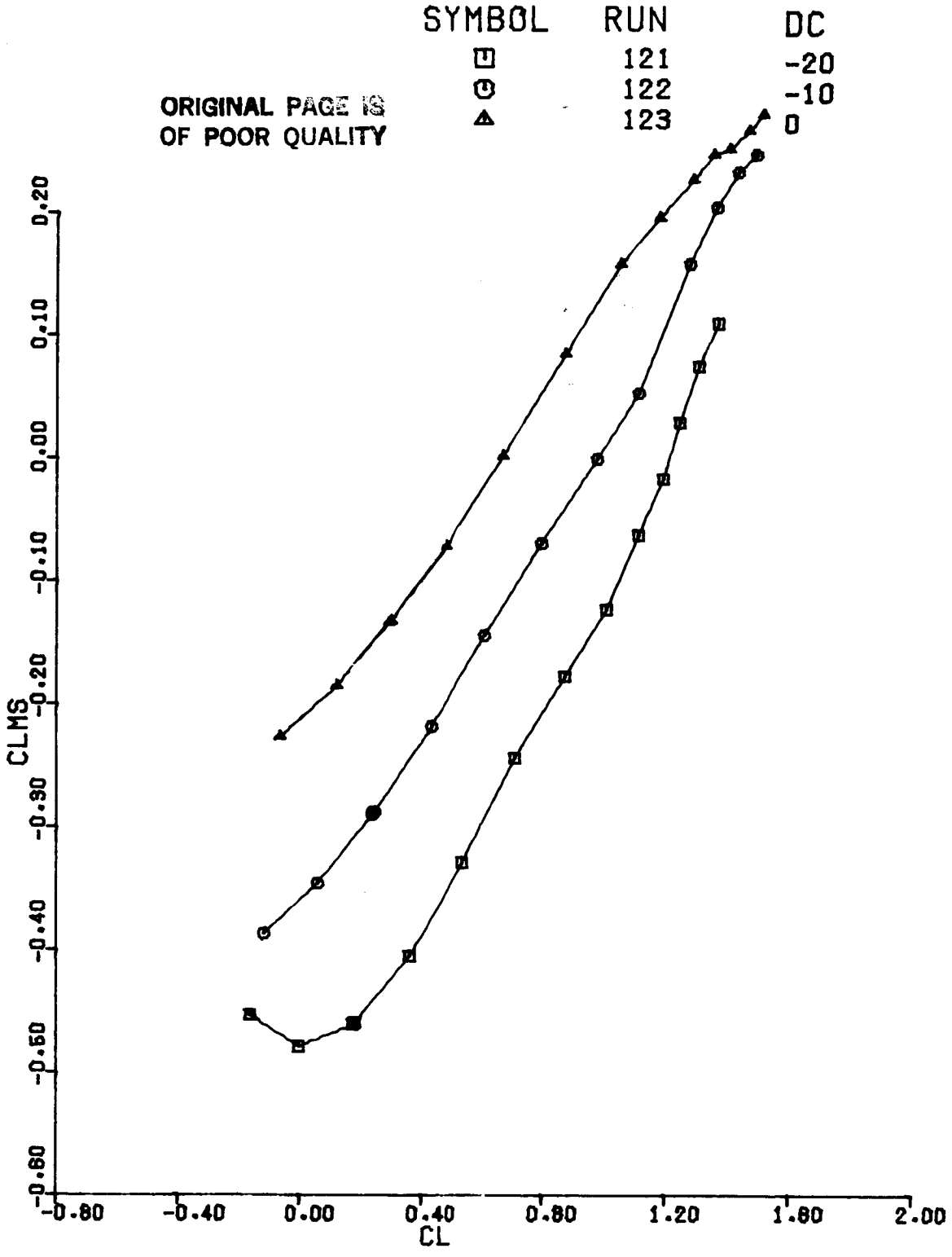

Figure 29(c). CLMS vs CL, DS = -5,
Configuration 2, BETA = 0, MACH = 0.6

SYMBOL	RUN	DC
□	124	0
○	125	-10
△	126	-20

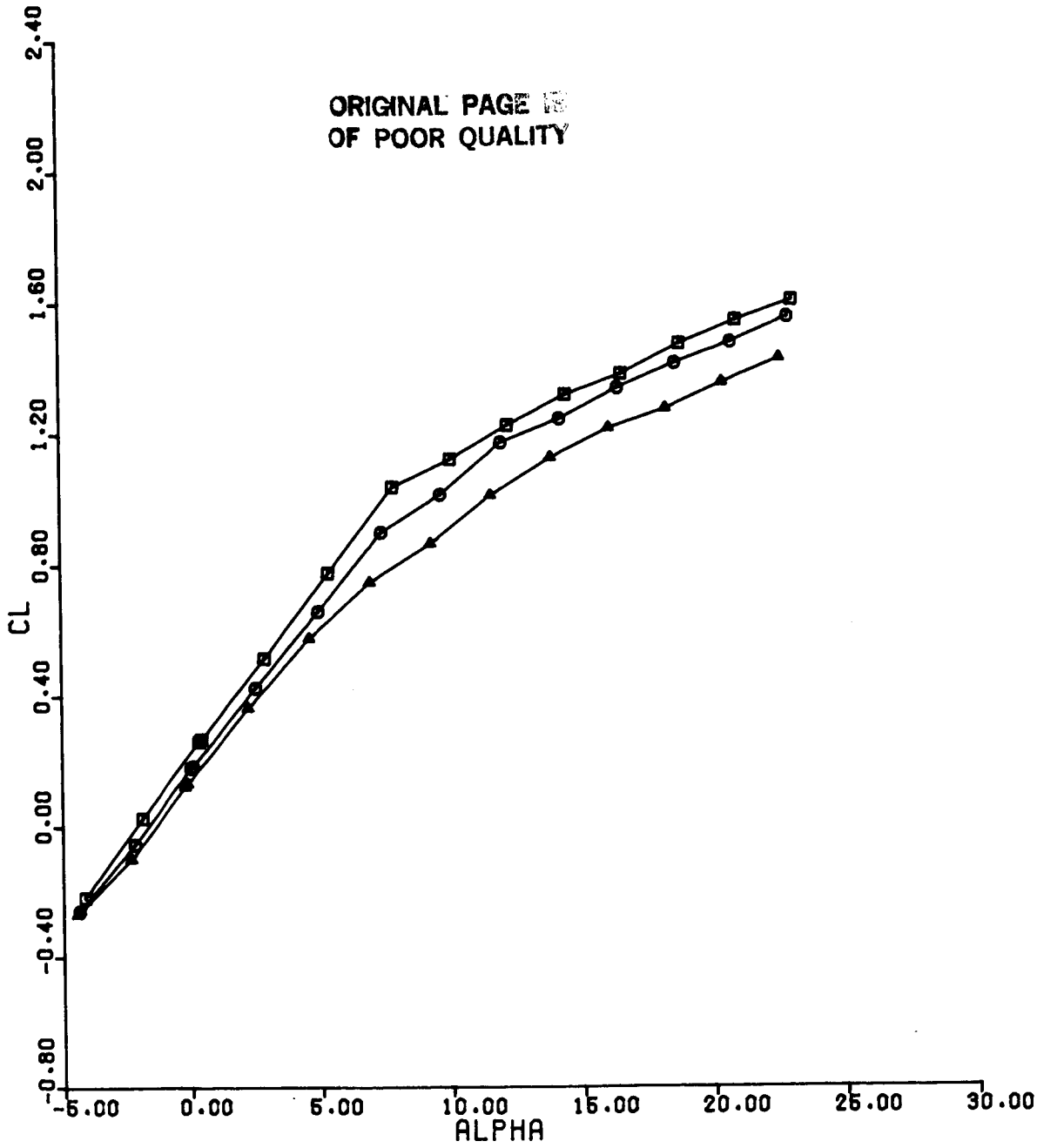

Figure 30(a). CL vs ALPHA, DS = -5,
Configuration 2, BETA = 0, MACH = 0.9

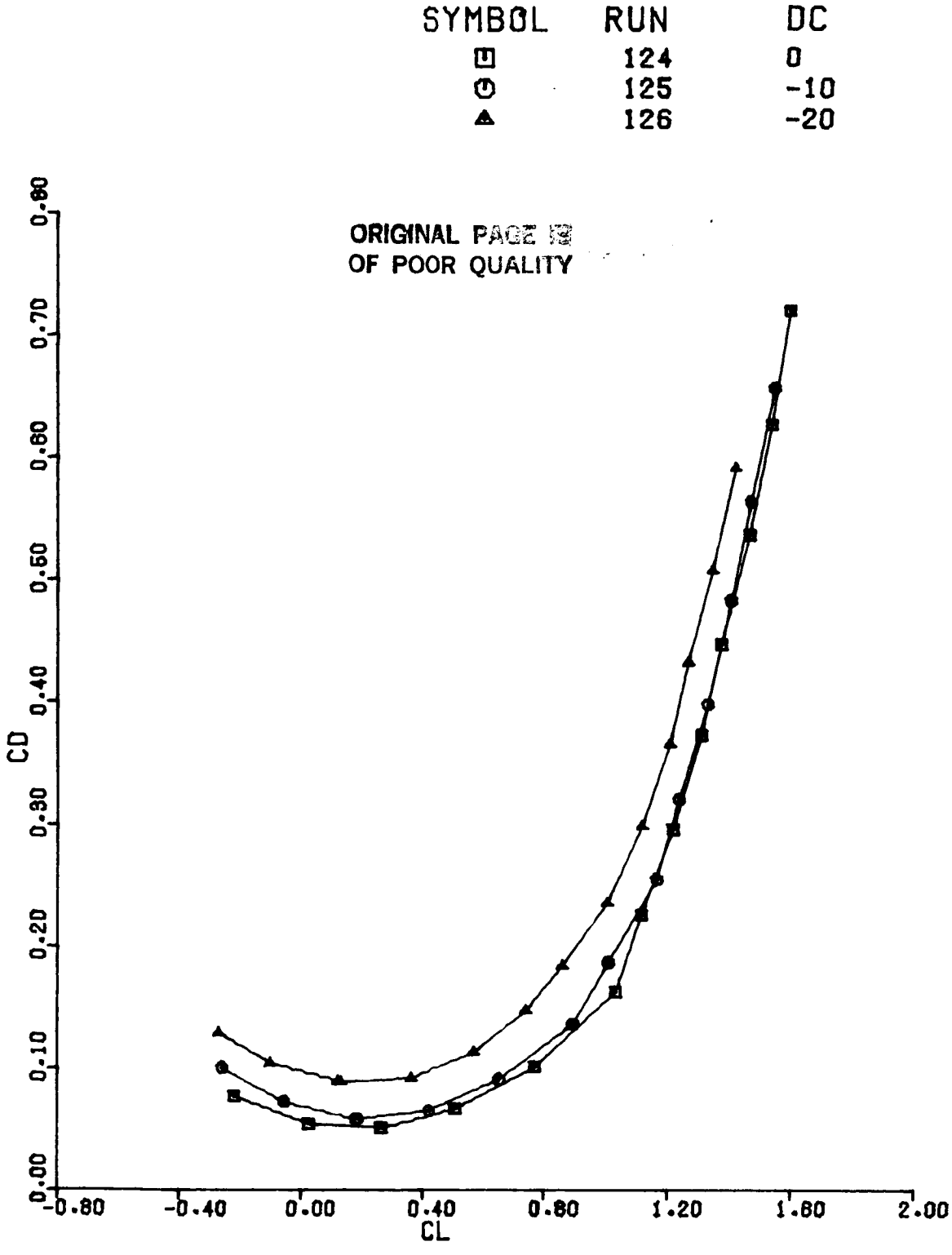

Figure 30(b). CD vs CL, DS = -5,
Configuration 2, BETA = 0, MACH = 0.9

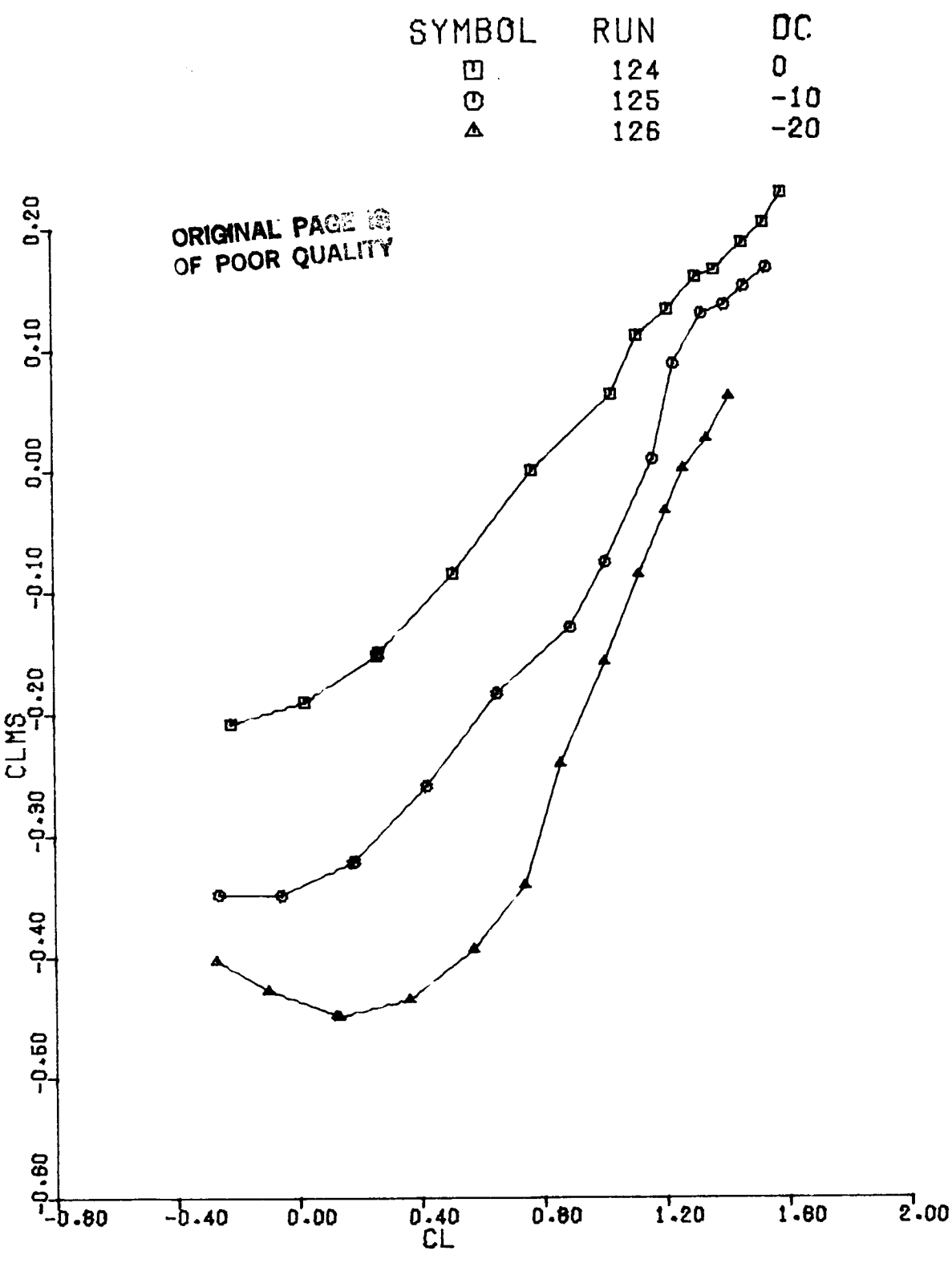

Figure 30(c). CLMS vs CL, DS = -5, Configuration 2, BETA = 0, MACH = 0.9

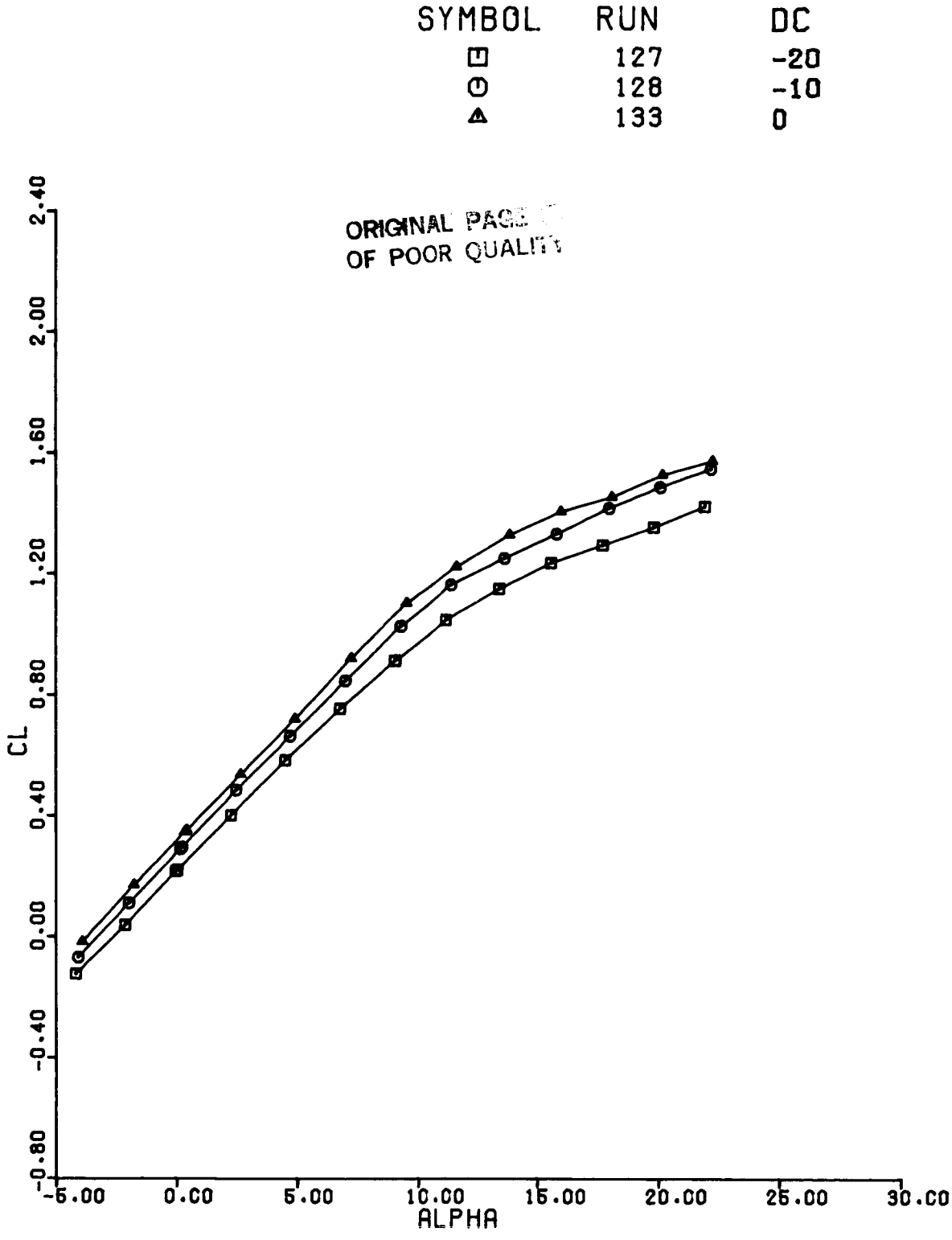

Figure 31(a). CL vs ALPHA, DS = 10,
Configuration 2, BETA = 0, MACH = 0.6

SYMBOL	RUN	DC
□	127	-20
○	128	-10
△	133	0

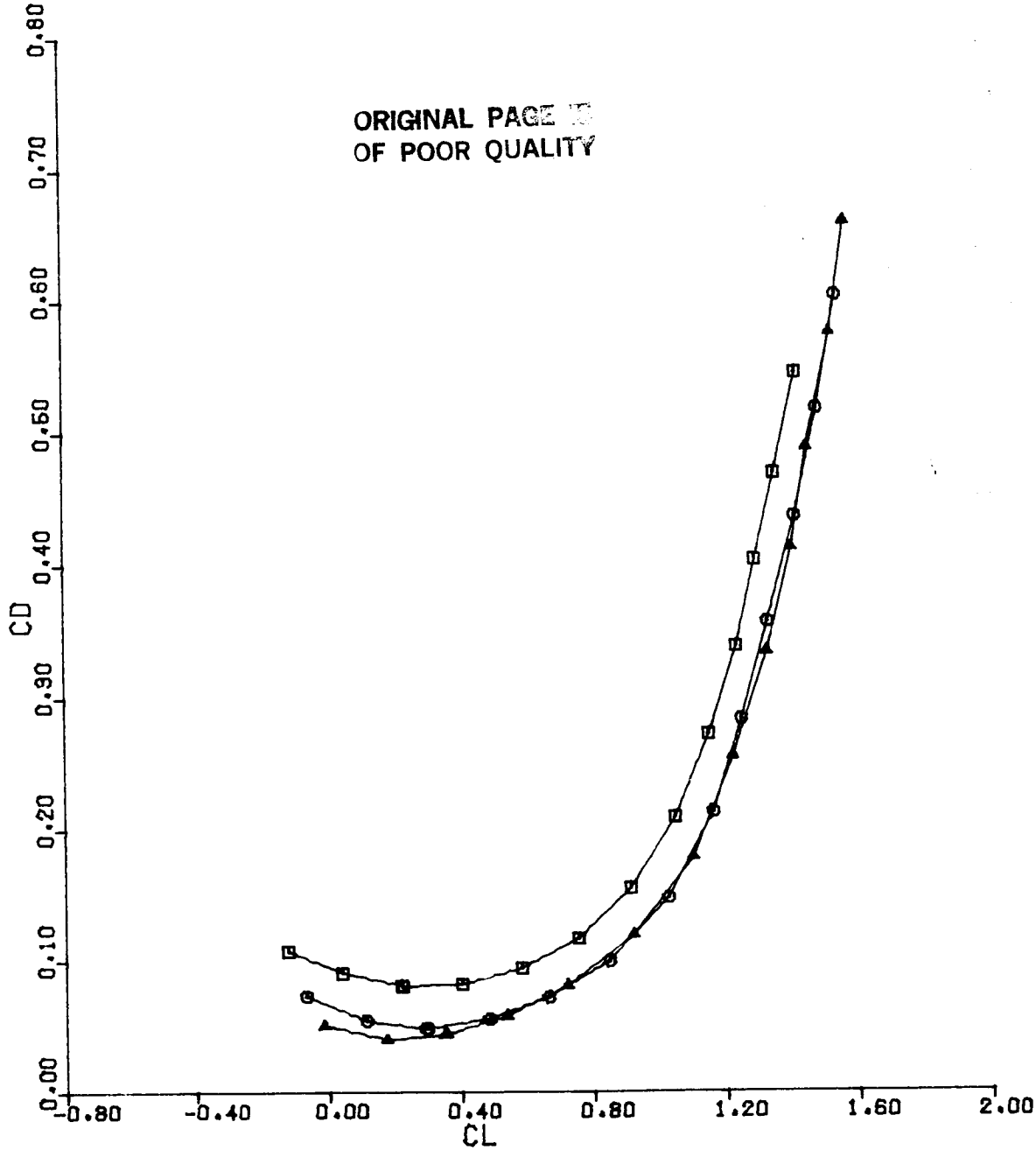

Figure 31(b). CD vs CL, DS = 10,
Configuration 2, BETA = 0, MACH = 0.6

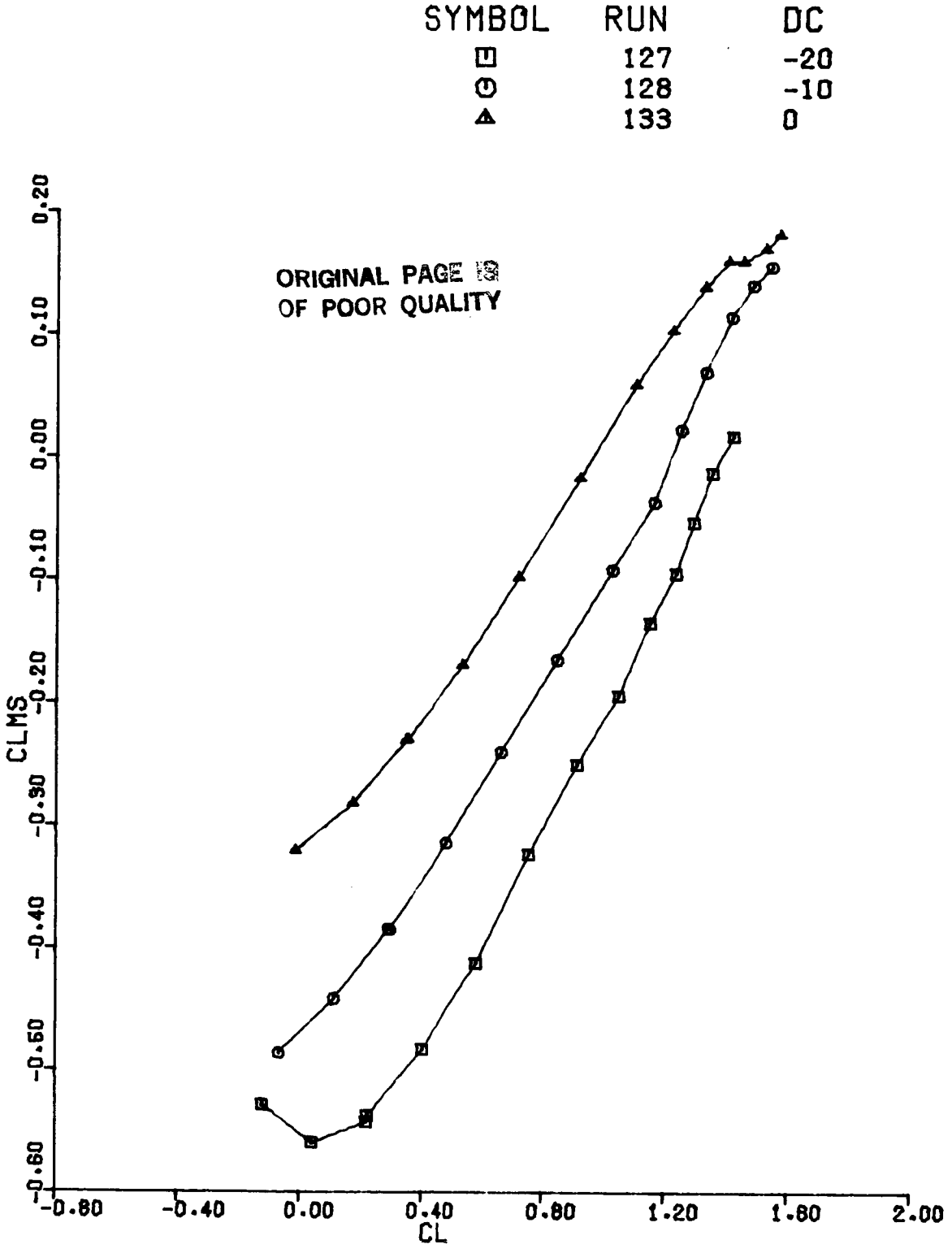

Figure 31(c). CLMS vs CL, DS = 10, Configuration 2, BETA = 0, MACH = 0.6

SYMBOL	RUN	DC
□	134	0
○	139	-10
△	140	-20

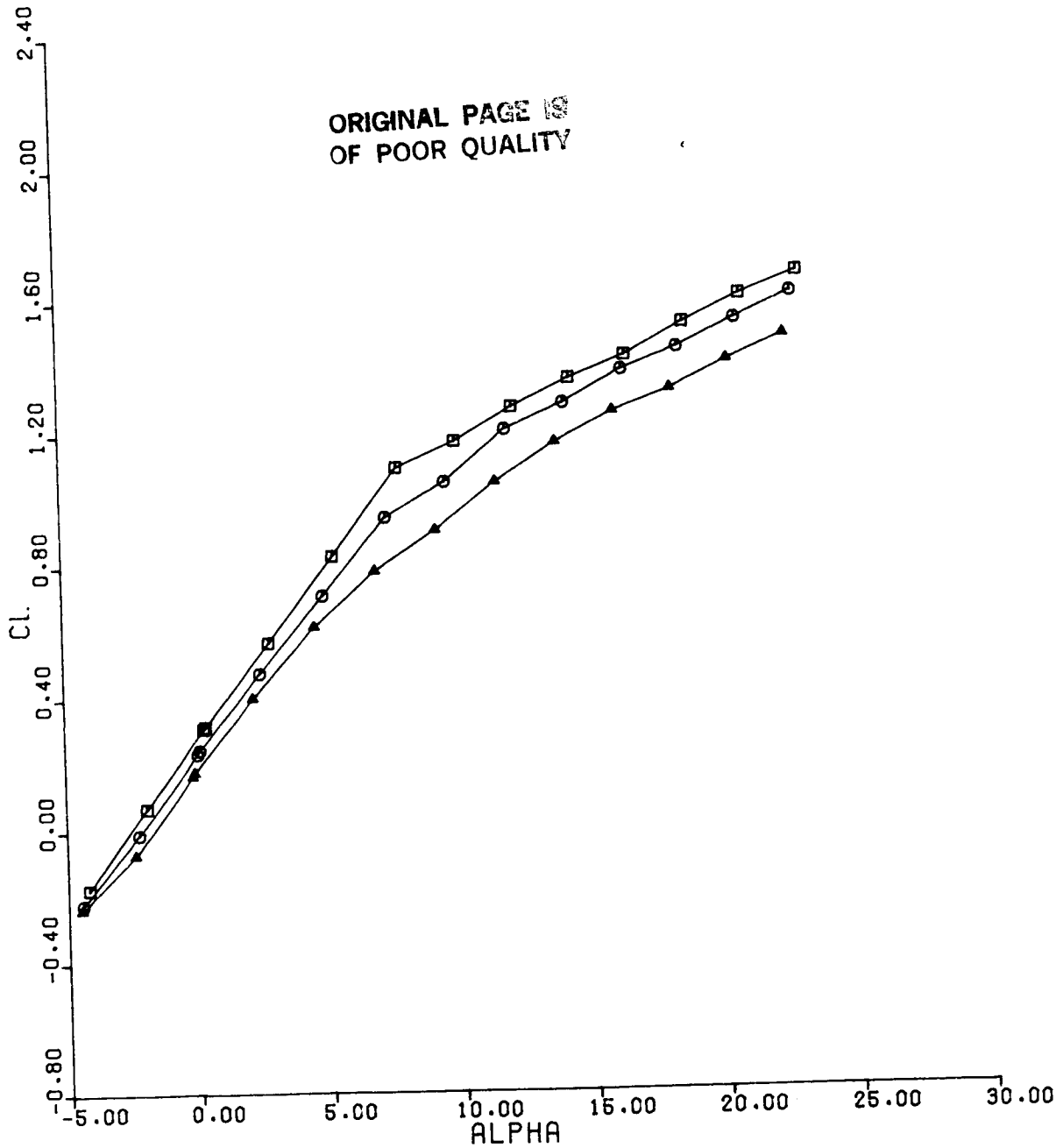

Figure 32(a). CL vs ALPHA, DS = 10,
Configuration 2, BETA = 0, MACH = 0.9

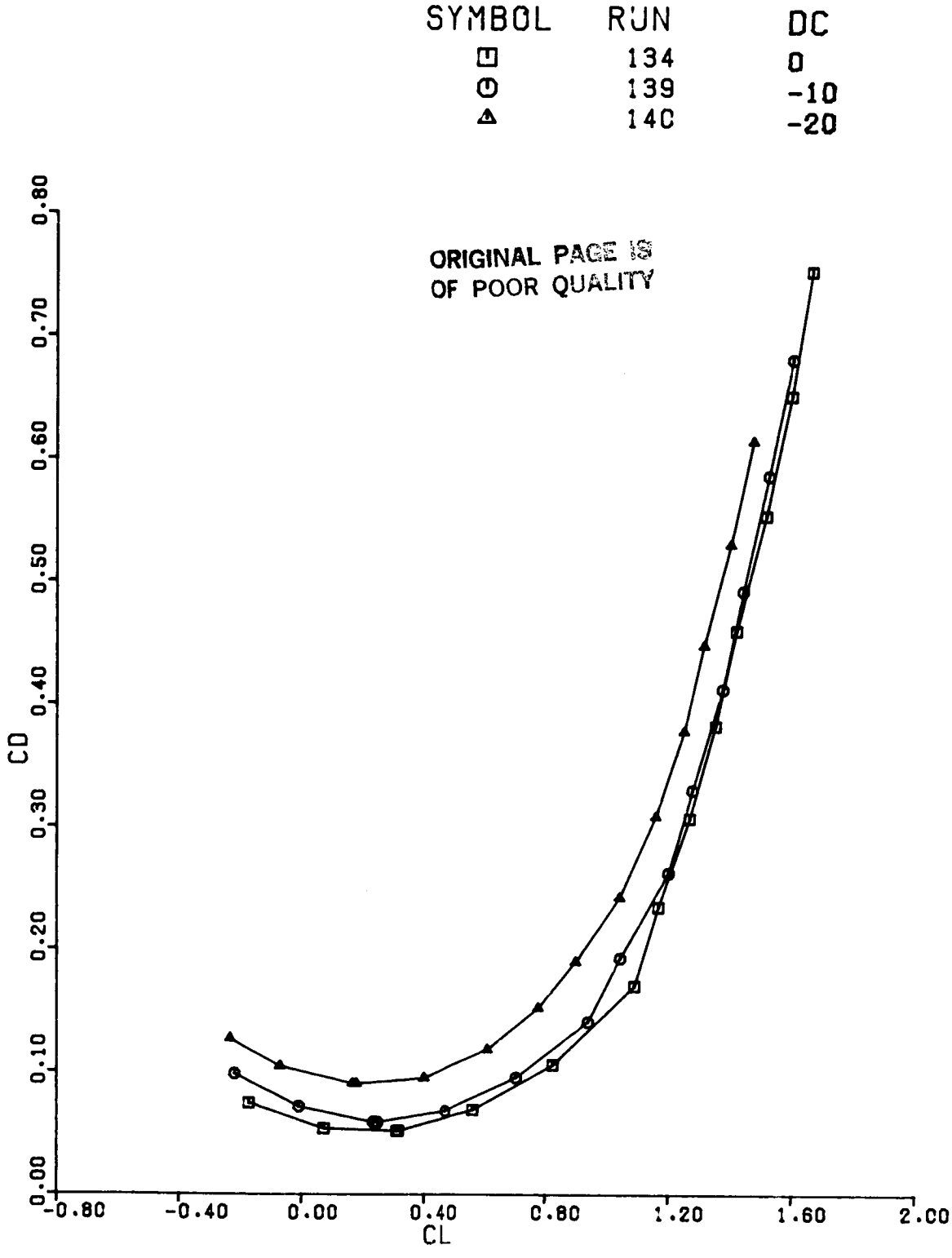

Figure 32(b). CD vs CL, DS = 10,
Configuration 2, BETA = 0, MACH = 0.9

SYMBOL	RUN	DC
□	134	0
○	139	-10
△	140	-20

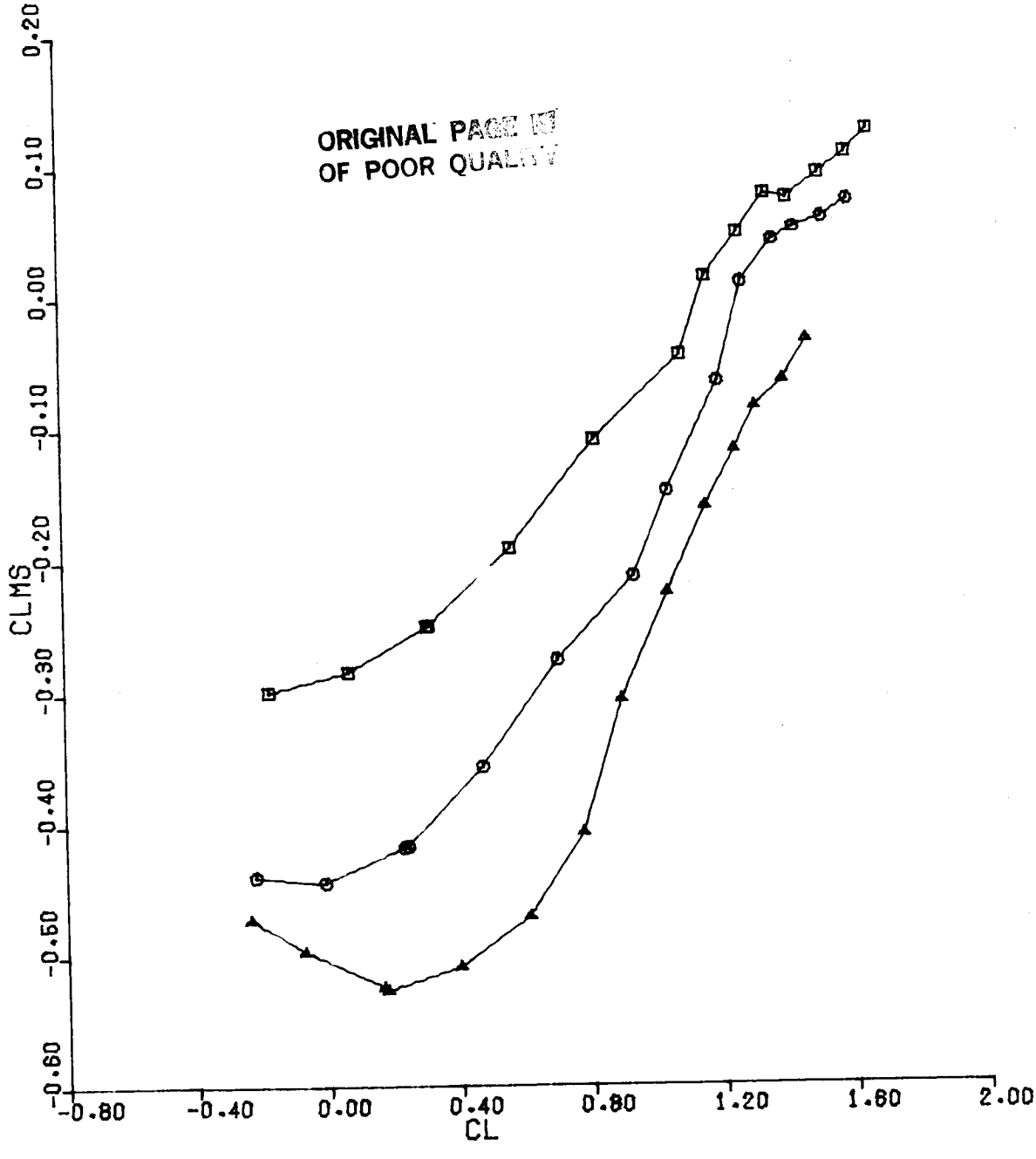

Figure 32(c). CLMS vs CL, DS = 10, Configuration 0, BETA = 0, MACH = 0.6

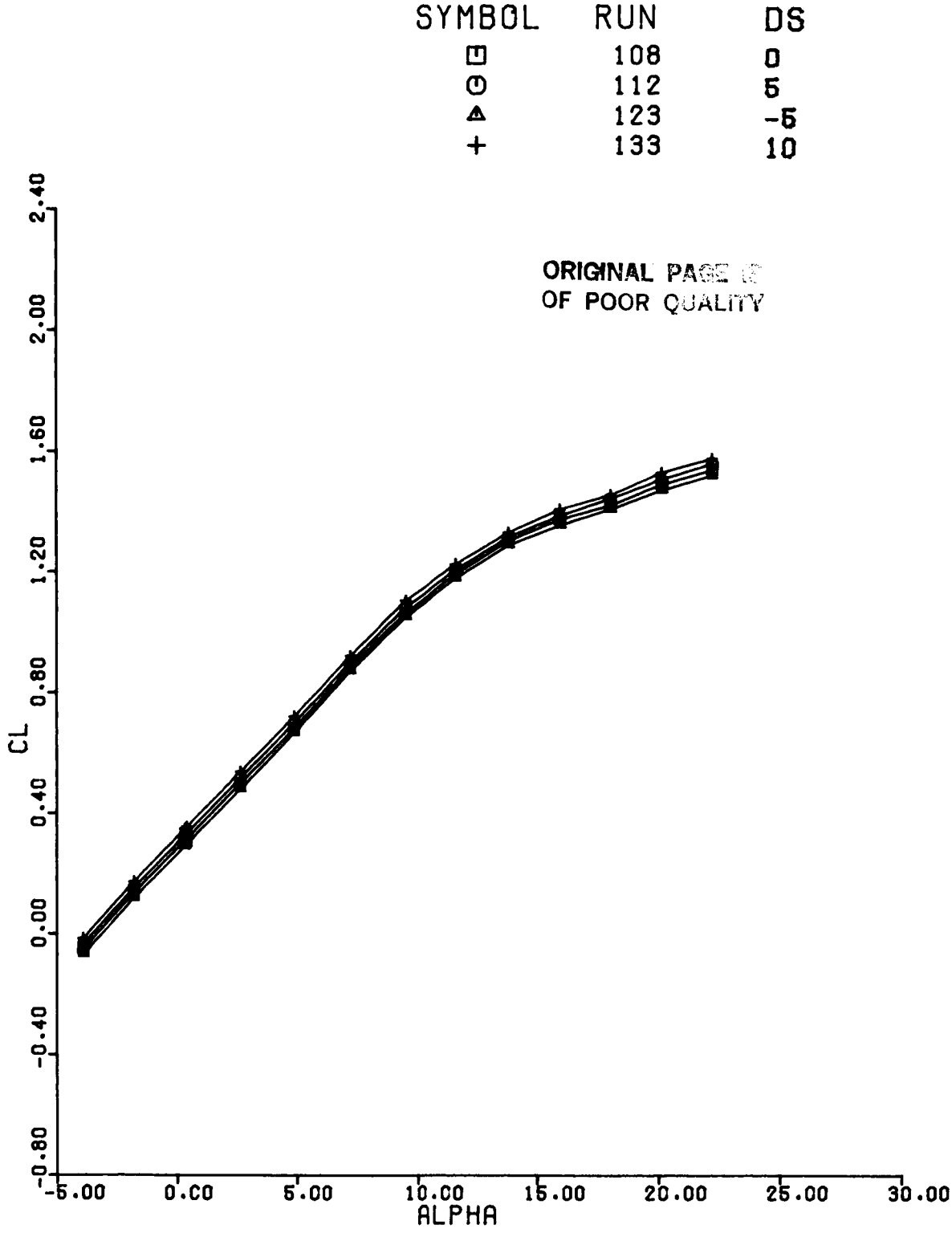

Figure 33(a). CL vs ALPHA, DC = 0, Configuration 2, BETA = 0, MACH = 0.6

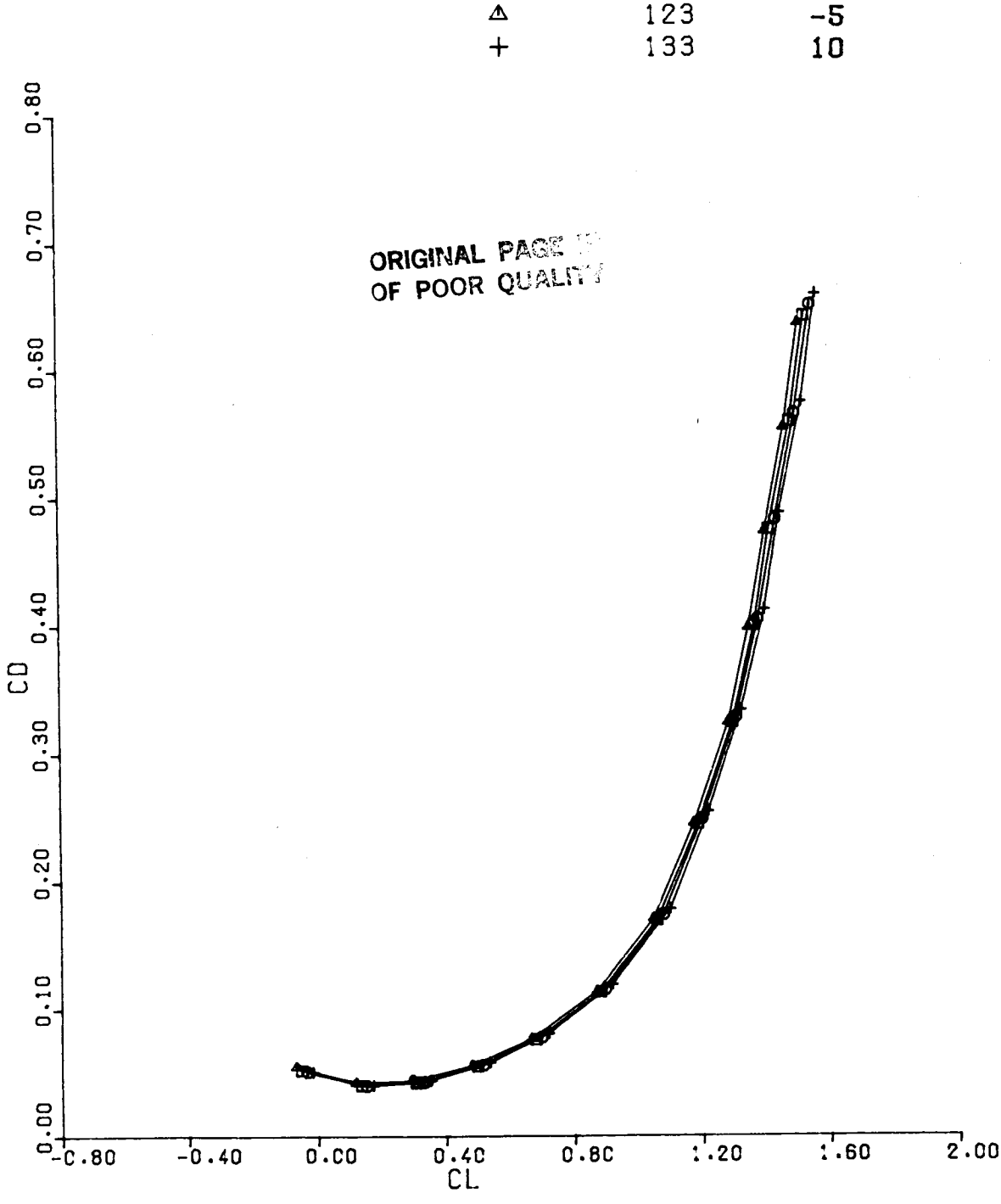

Figure 33(b). CD vs CL, DC = 0,
Configuration 2, BETA = 0, MACH = 0.6

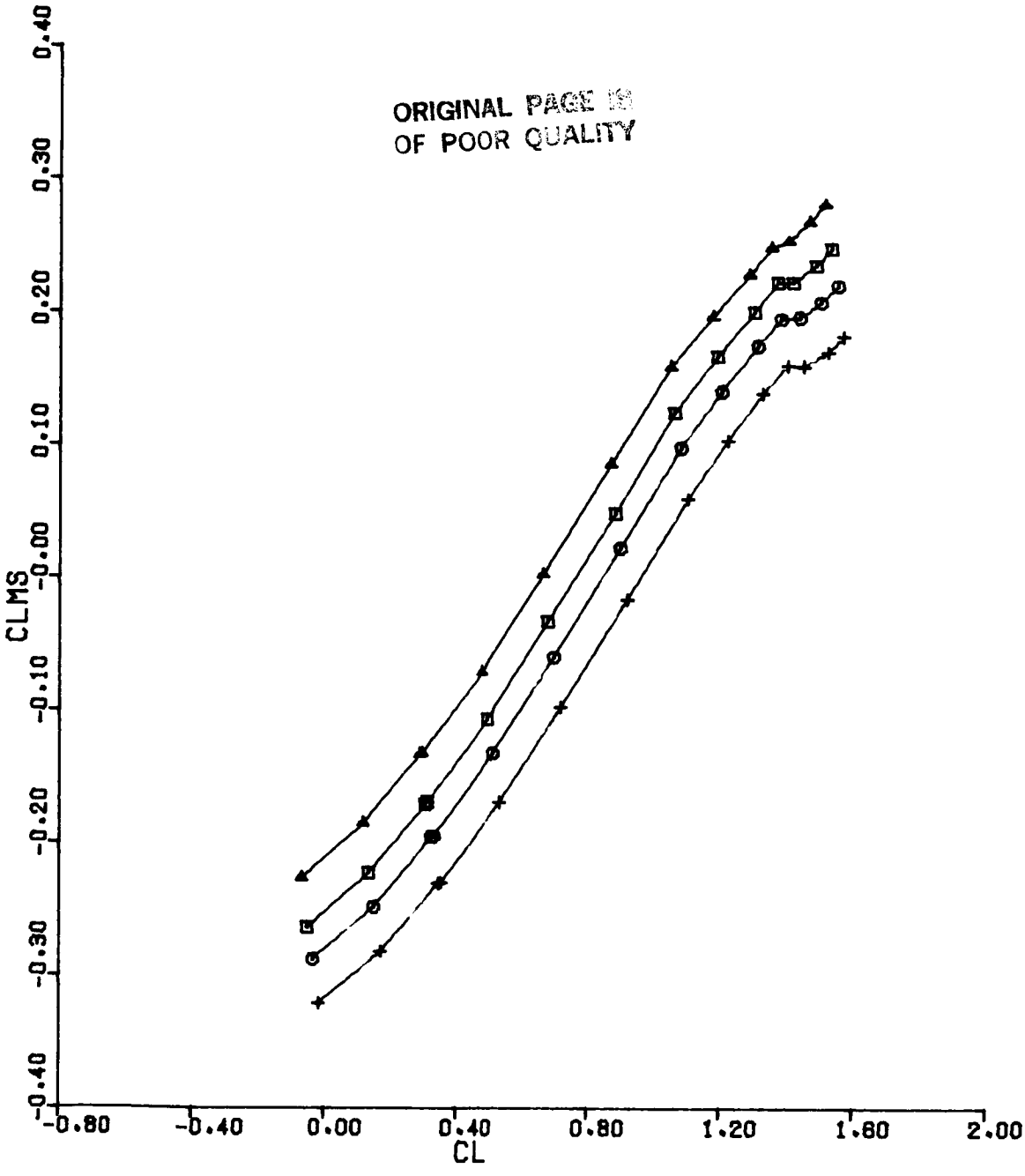

Figure 33(c). CLMS vs CL, DC = 0,
Configuration 2, BETA = 0, MACH = 0.6

SYMBOL	RUN	DS
□	117	5
○	124	-5
△	134	10

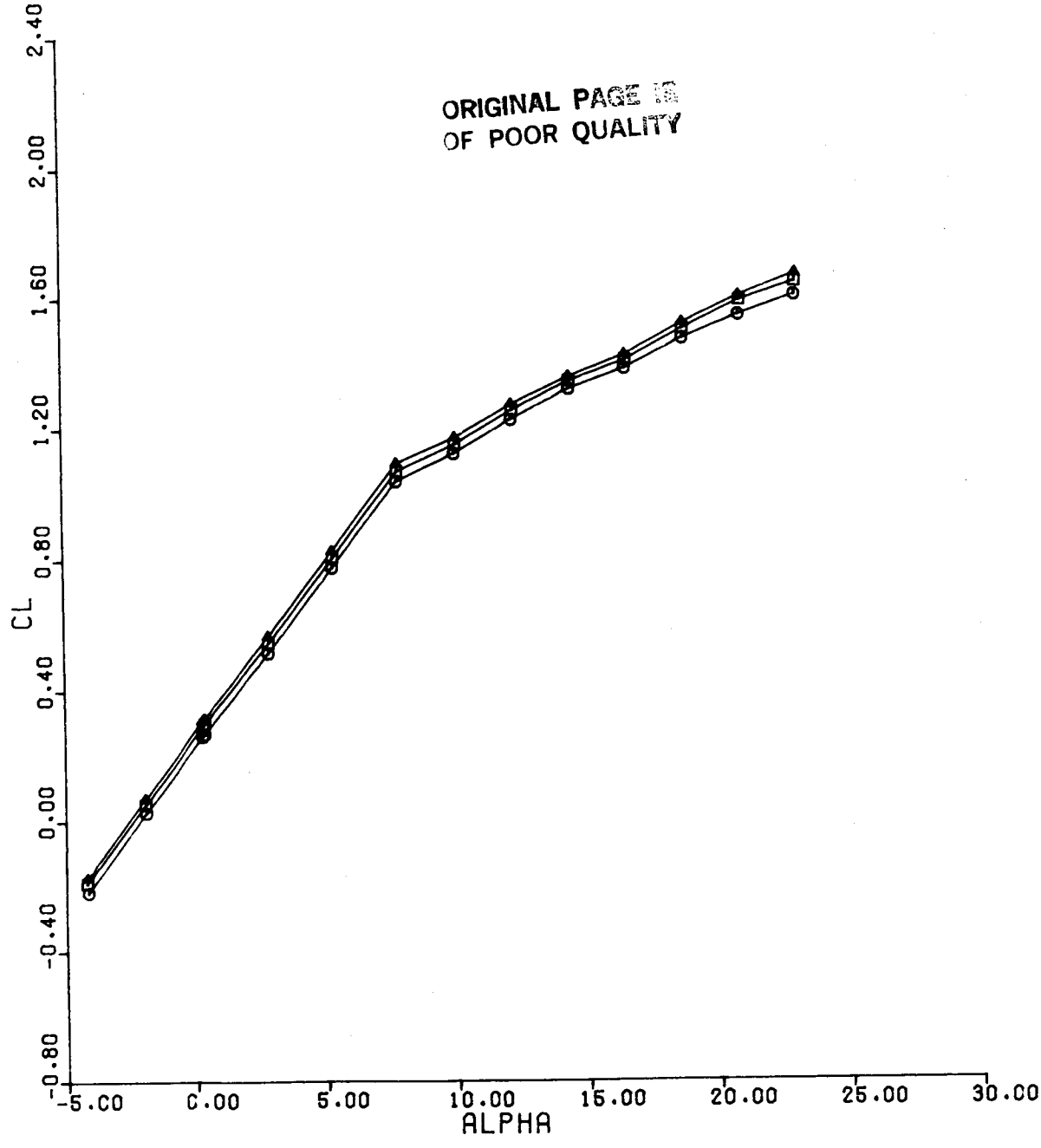

Figure 34(a). CL vs ALPHA, DC = 0,
Configuration 2, BETA = 0, MACH = 0.9

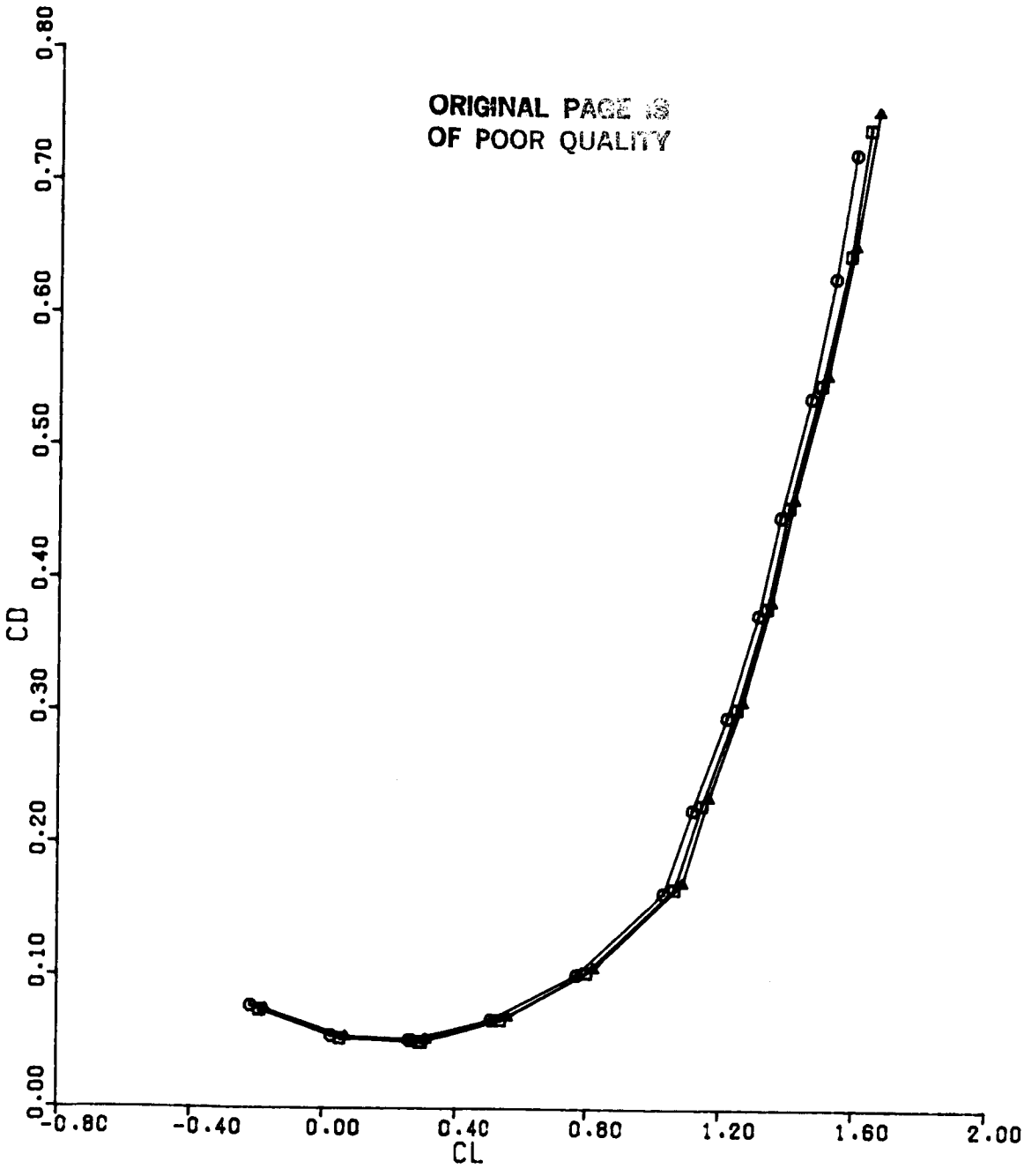

Figure 34(b). CD vs CL, DC = 0,
Configuration 2, BETA = 0, MACH = 0.9

SYMBOL	RUN	DS
⊡	117	5
⊙	124	-5
△	134	10

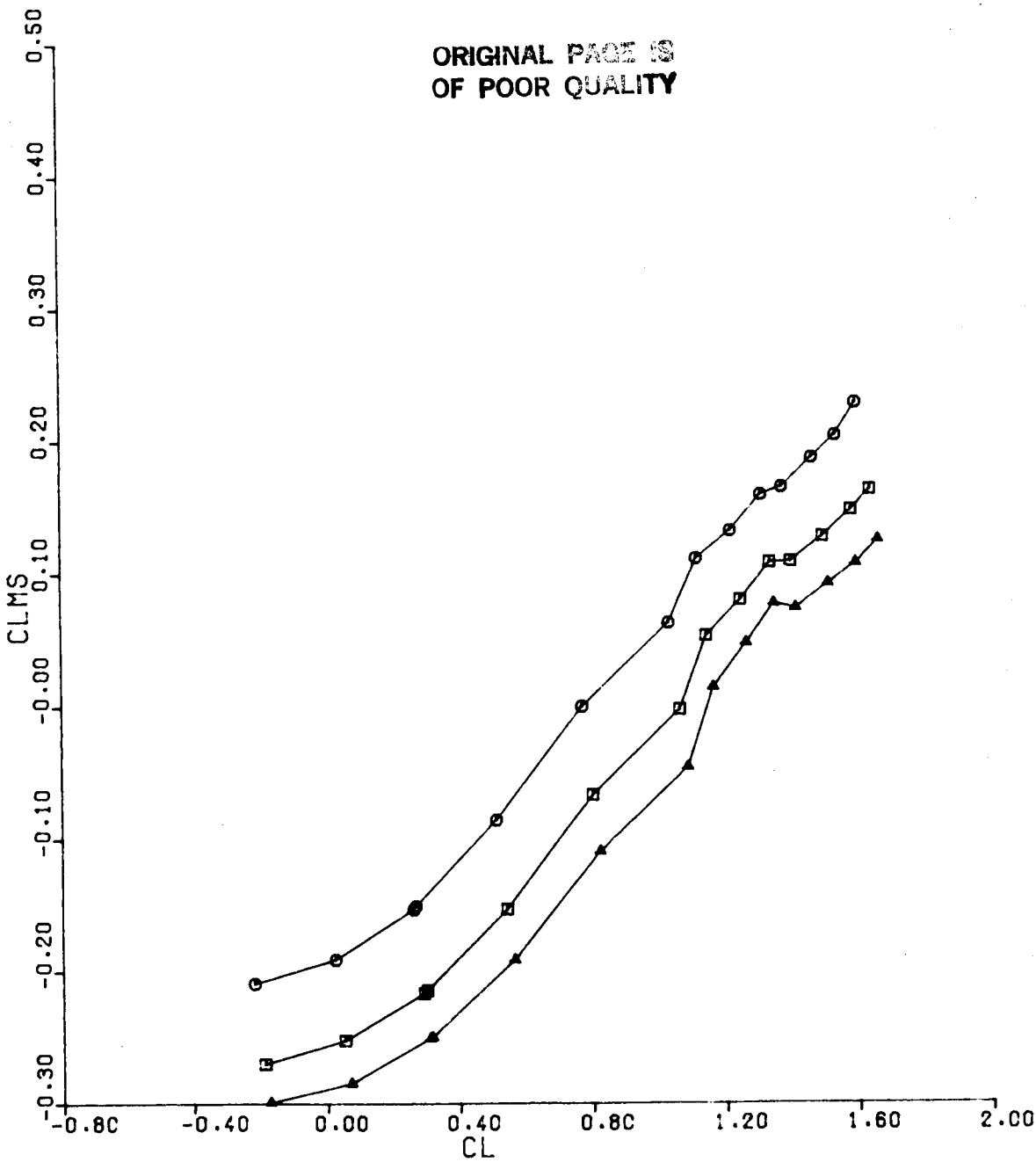

Figure 34(c). CLMS vs CL, DC = 0,
Configuration 2, BETA = 0, MACH = 0.9

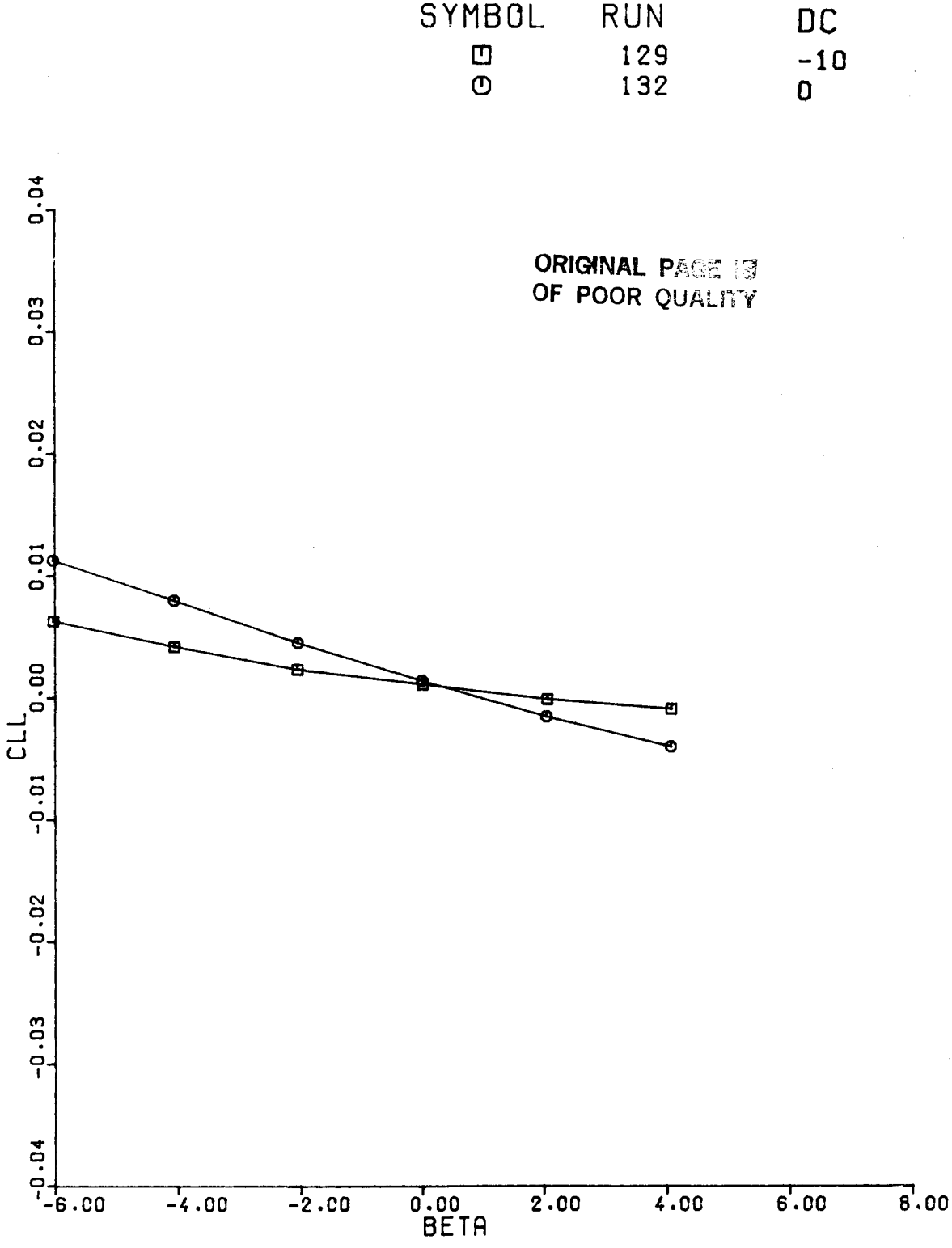

Figure 35(a). CLL vs BETA, DS = 10,
Configuration 2, ALPHA = 10, MACH = 0.6

SYMBOL	RUN	DC
⊡	129	-10
⊙	132	0

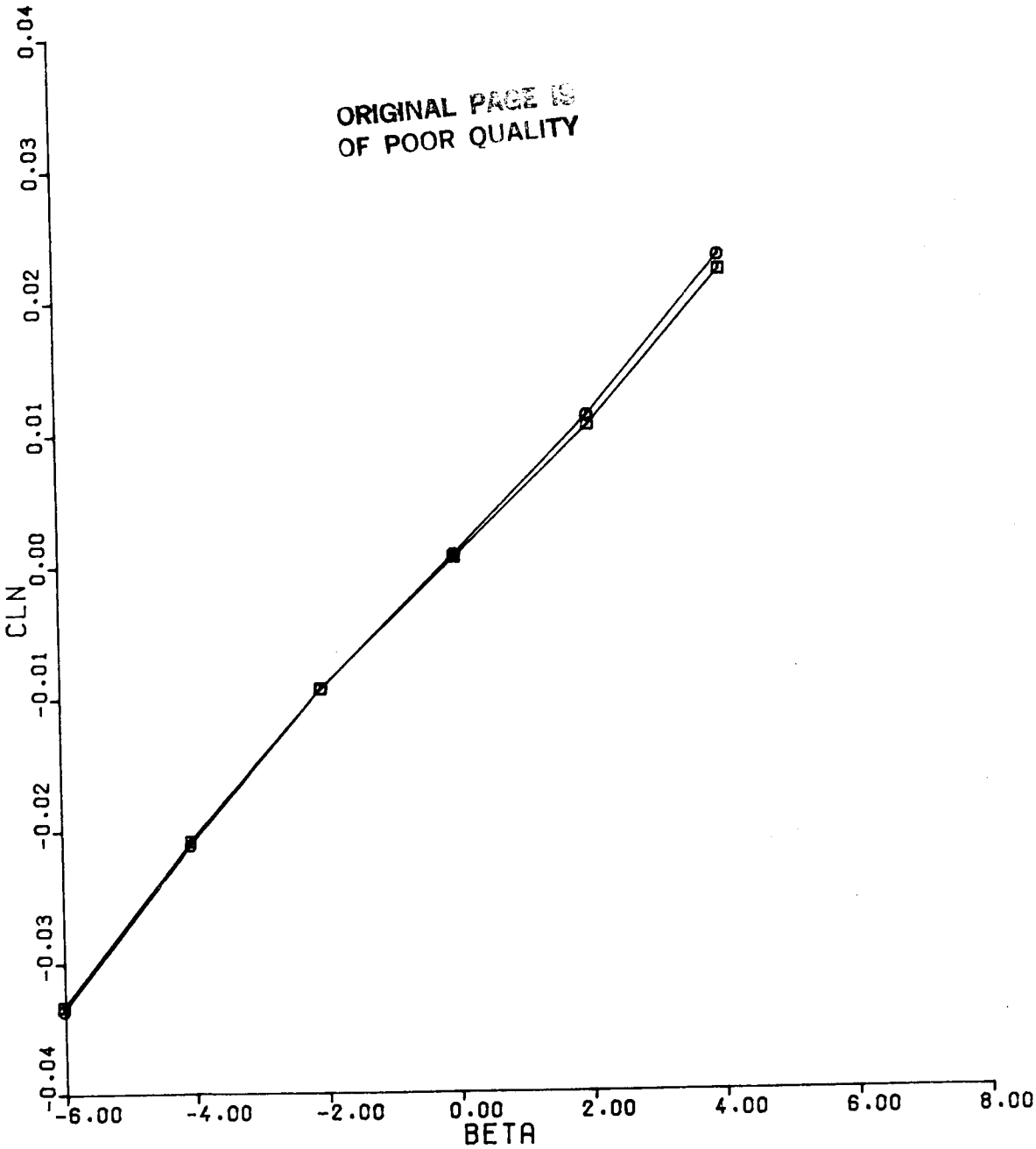

Figure 35(b). CLN vs BETA, DC = 10, Configuration 2, ALPHA = 10, MACH = 0.6

SYMBOL	RUN	DC
⊡	129	-10
⊙	132	0

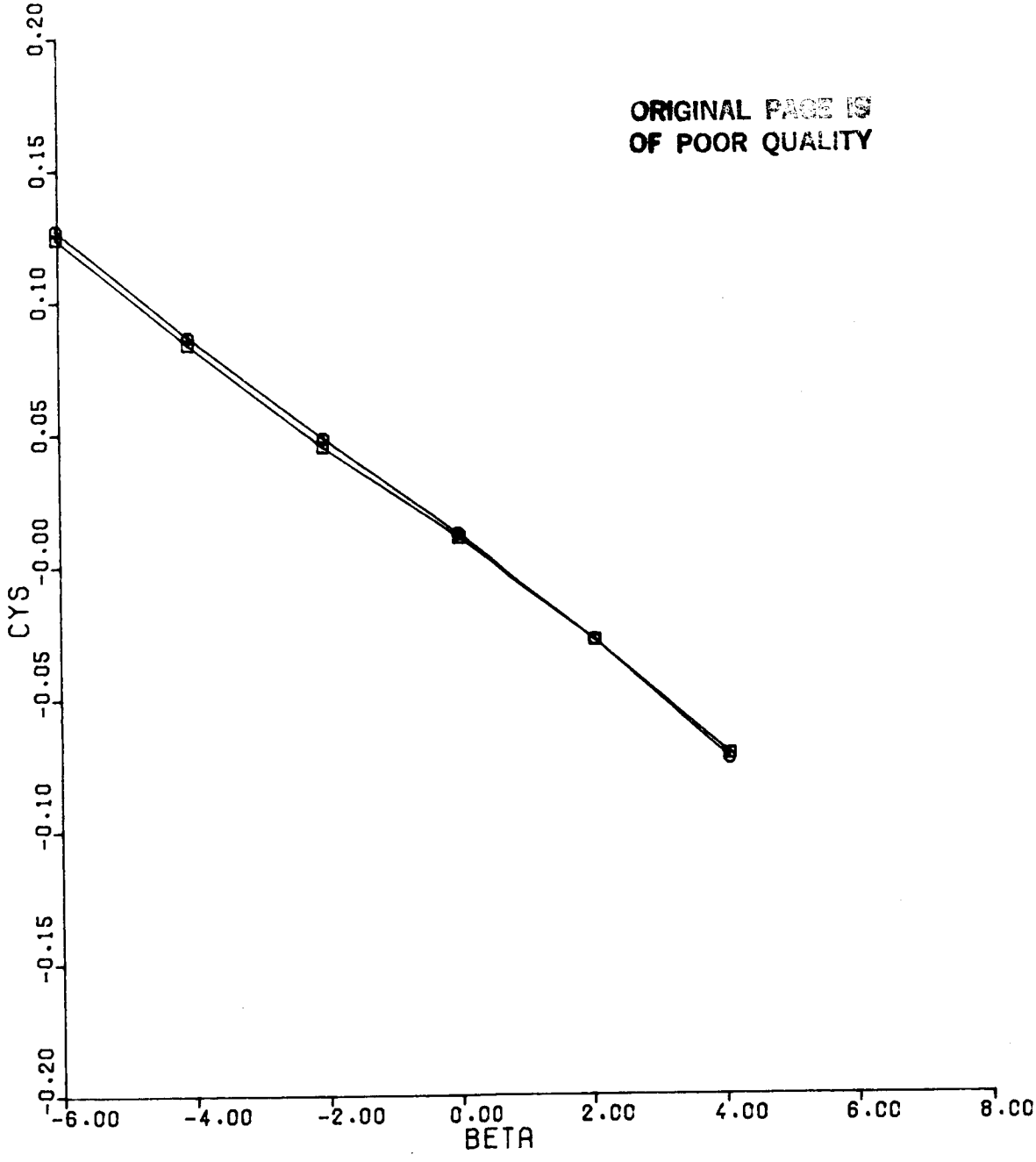

Figure 35(c). CYS vs BETA, DC = 10,
Configuration 2, ALPHA = 10, MACH = 0.6

SYMBOL	RUN	DC
⊡	130	-10
⊙	131	0

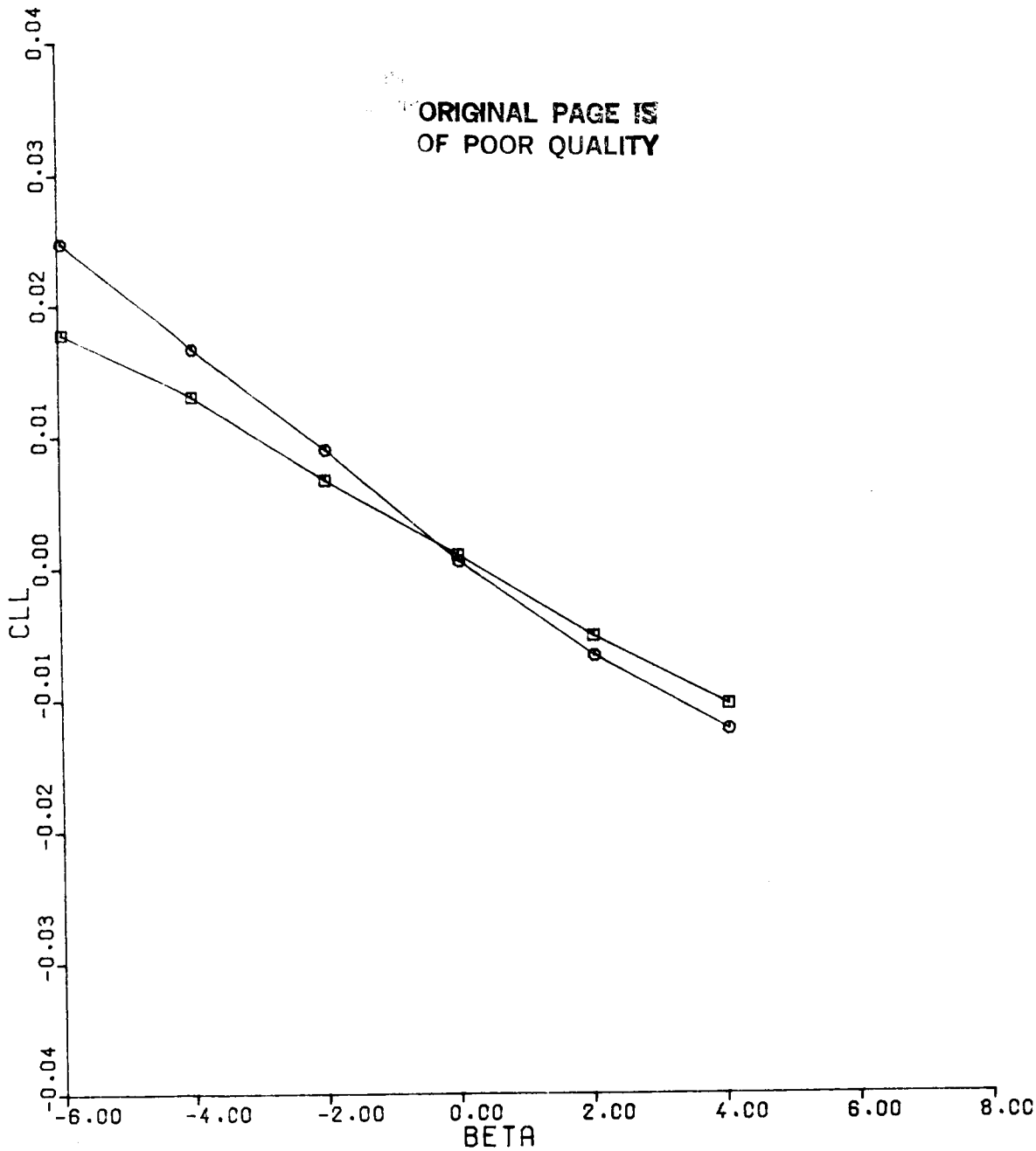

Figure 36(a). CLL vs BETA, DS = 10,
Configuration 2, ALPHA = 15, MACH = 0.6

SYMBOL	RUN	DC
□	130	-10
○	131	0

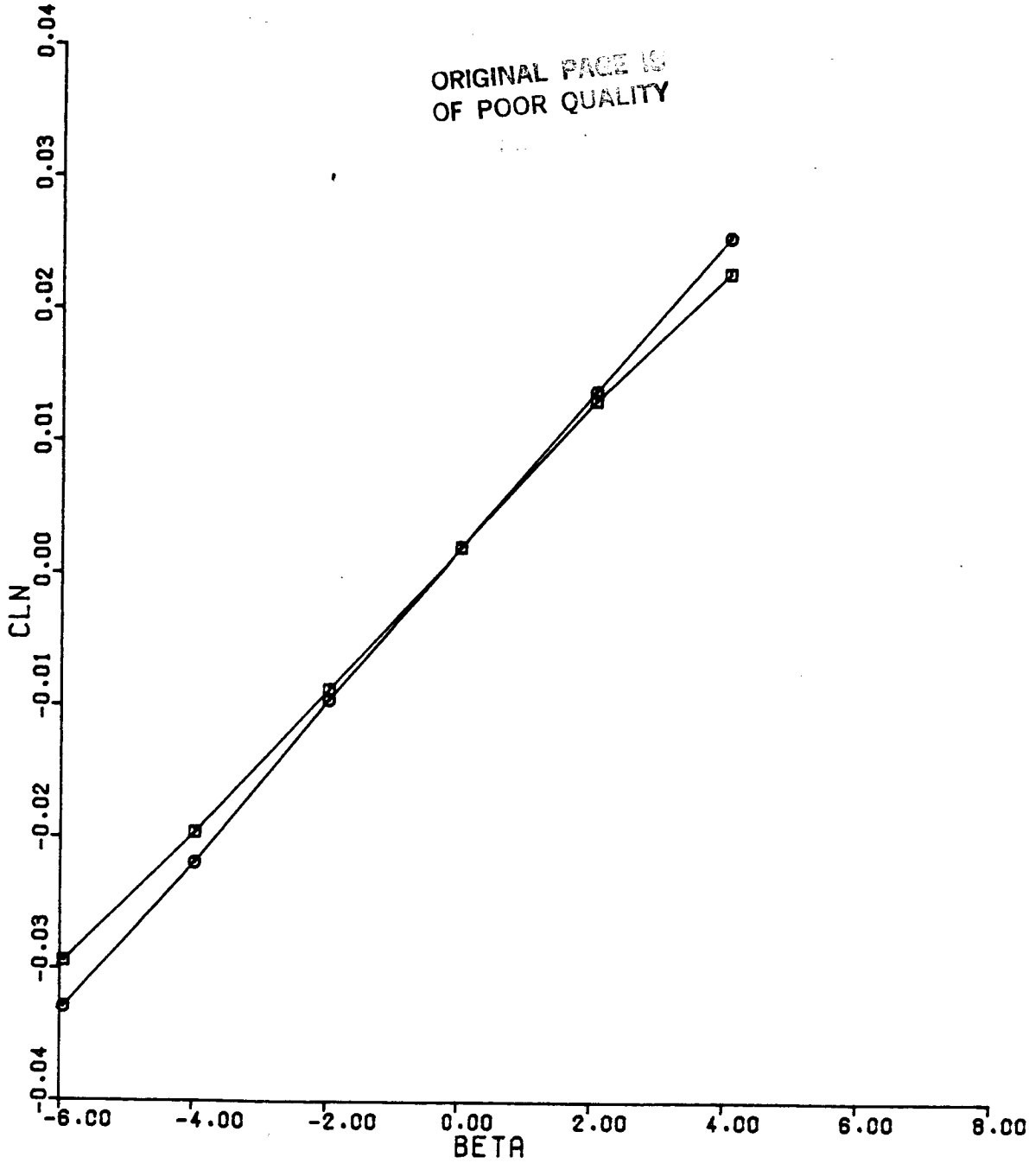

Figure 36(b). CLN vs BETA, DS = 10,
Configuration 2, ALPHA = 15, MACH = 0.6

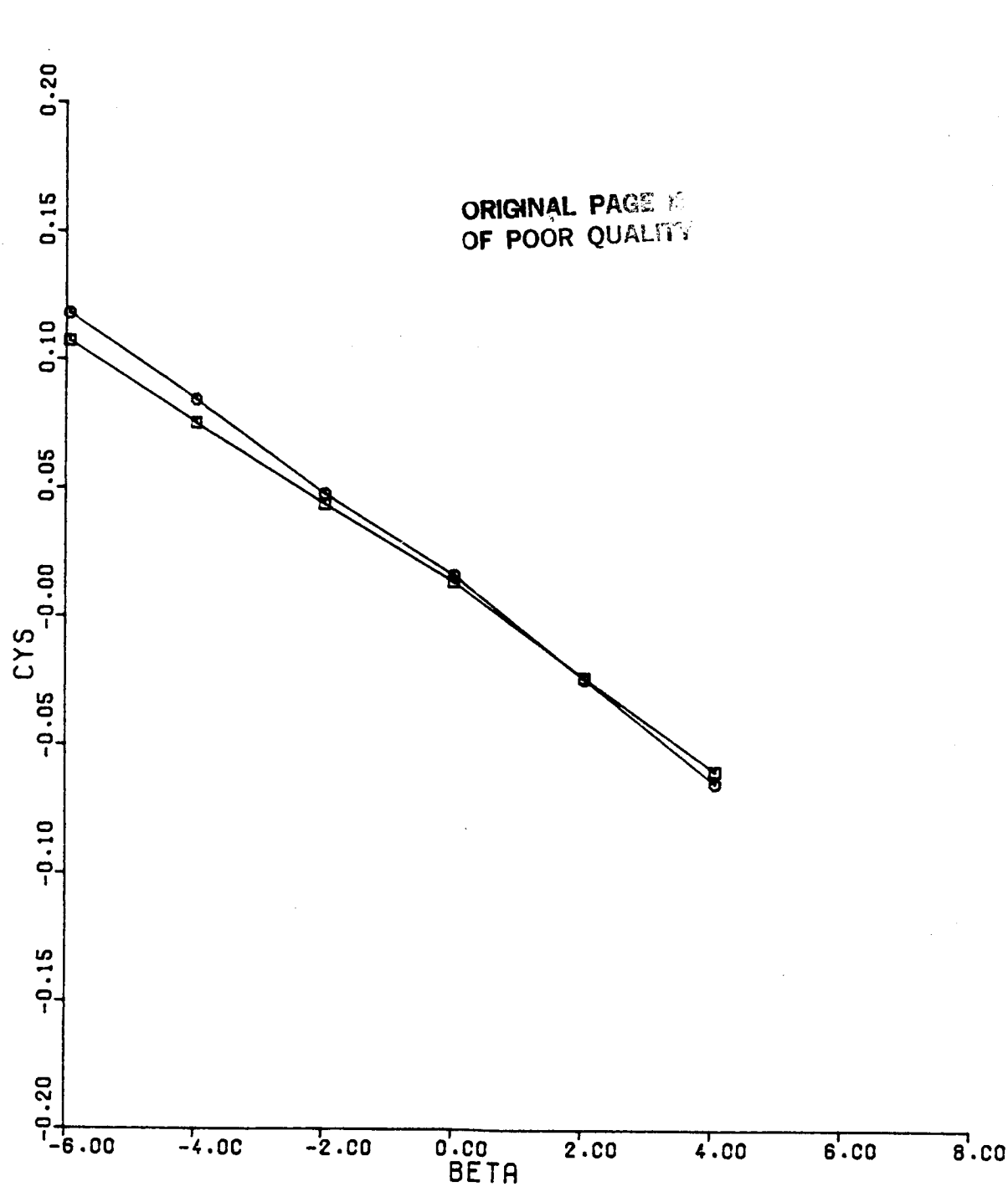

Figure 36(c). CYS vs BETA, DS = 10, Configuration 2, ALPHA = 15, MACH = 0.6

SYMBOL	RUN	DC	ALPHA
□	129	-10	10
○	130	0	10
△	131	-10	15
+	132	0	15

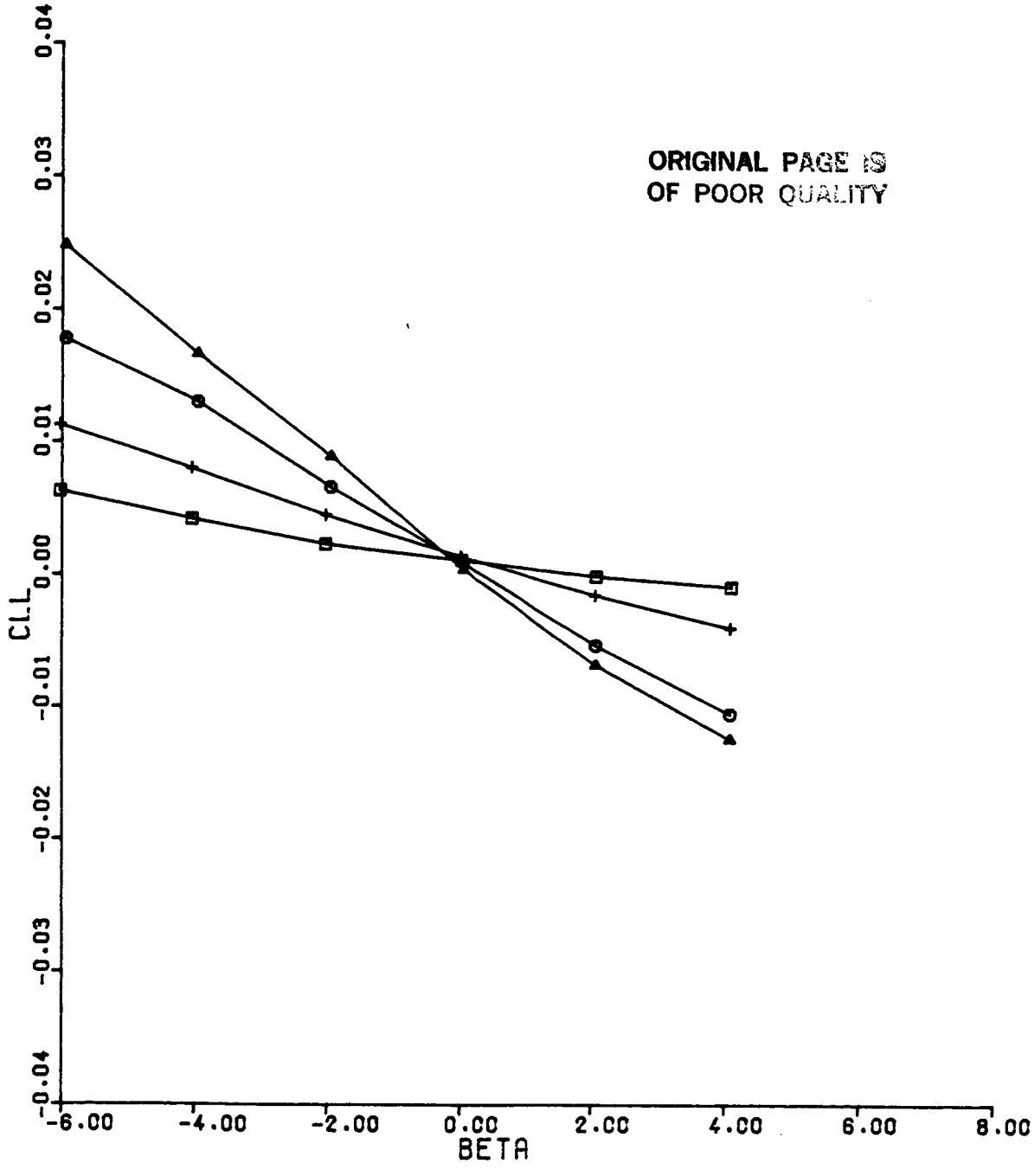

Figure 37(a). CLL vs BETA, DS = 10,
Configuration 2, MACH = 0.6

SYMBOL	RUN	DC	ALPHA
□	129	-10	10
○	130	0	10
△	131	-10	15
+	132	0	15

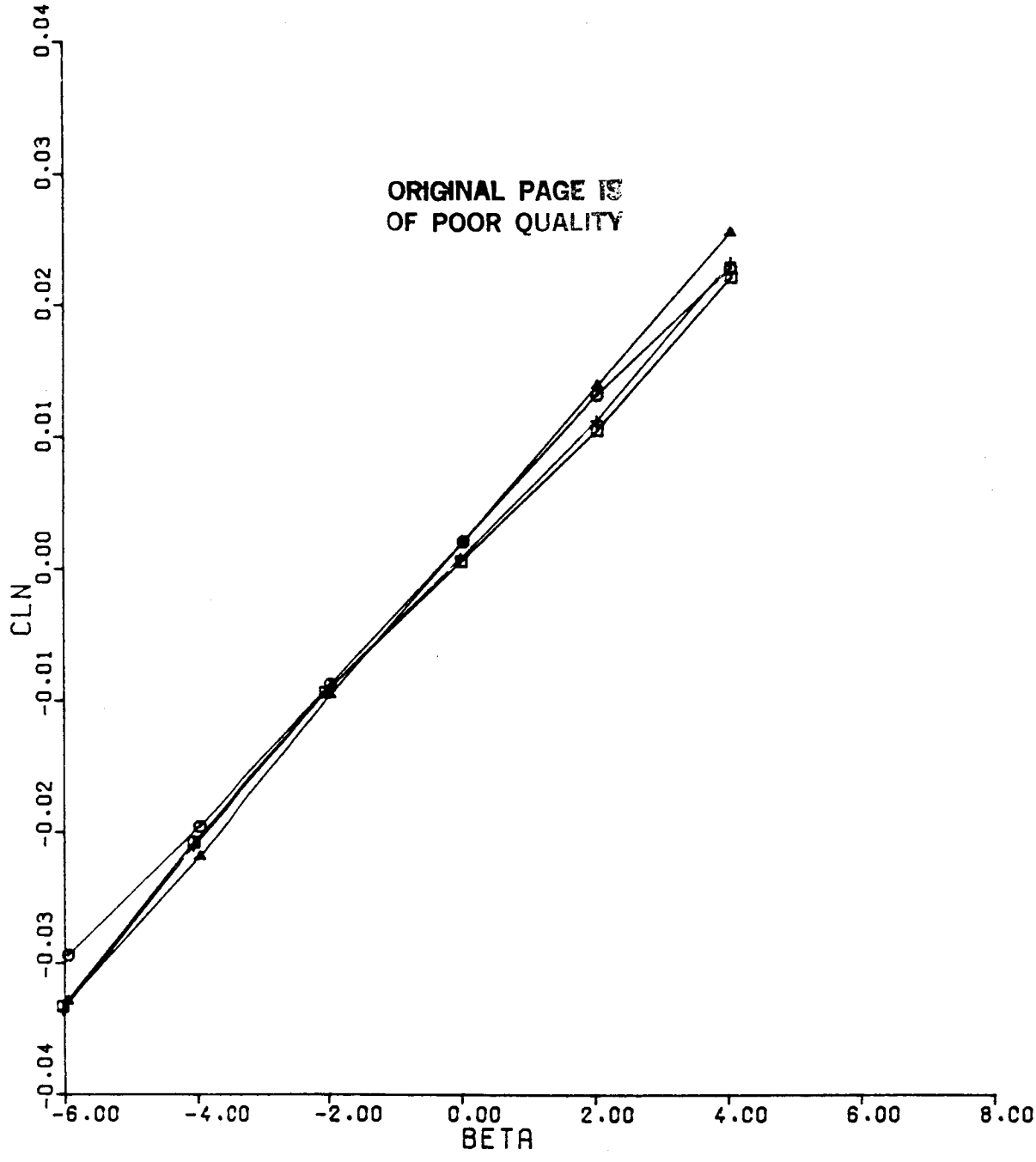

Figure 37(b). CLN vs BETA, DS = 10, Configuration 2, MACH = 0.6

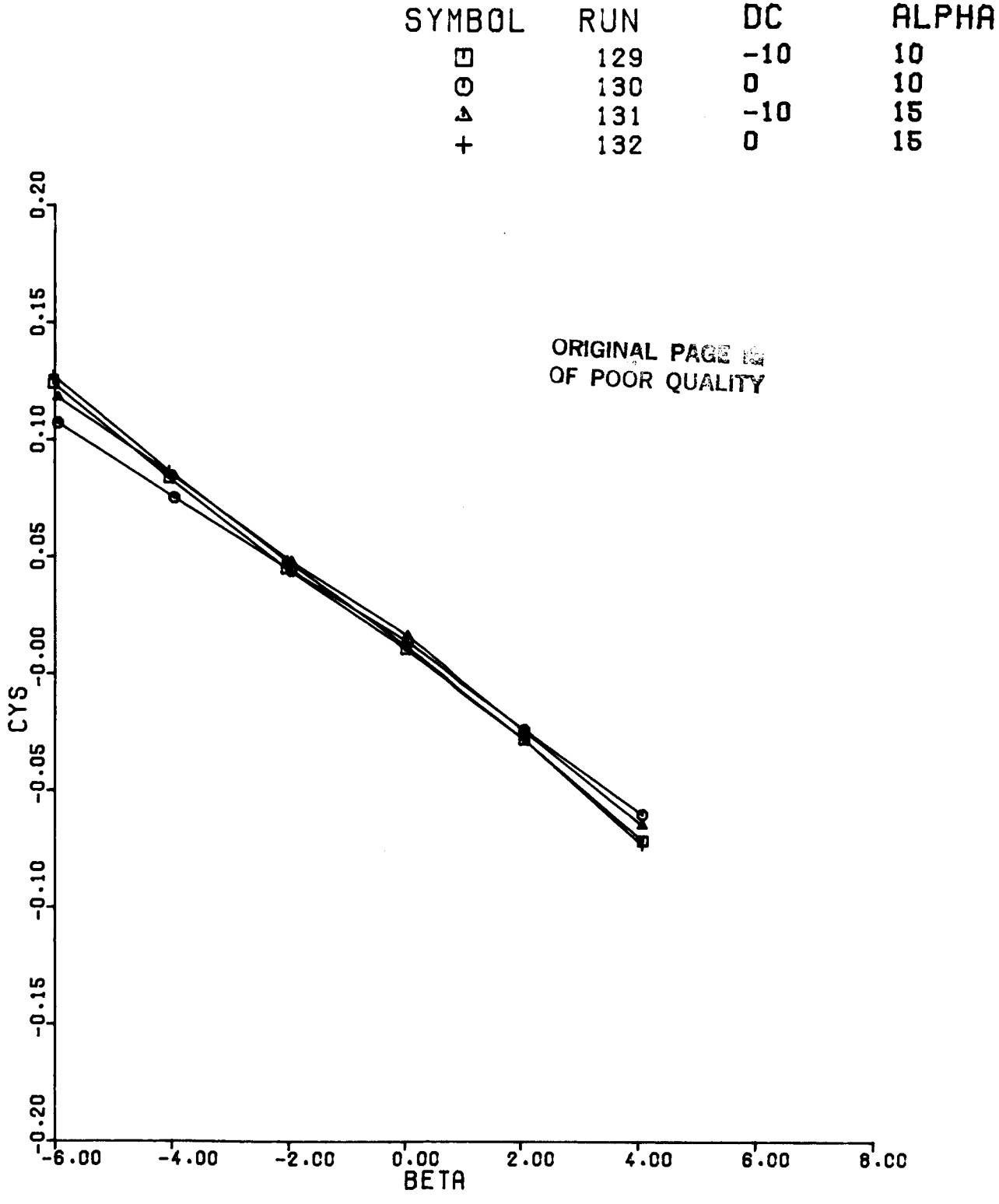

Figure 37(c). CYS vs BETA, DS = 10, Configuration 2, MACH = 0.6

SYMBOL	RUN	DC
□	135	0
○	138	-10

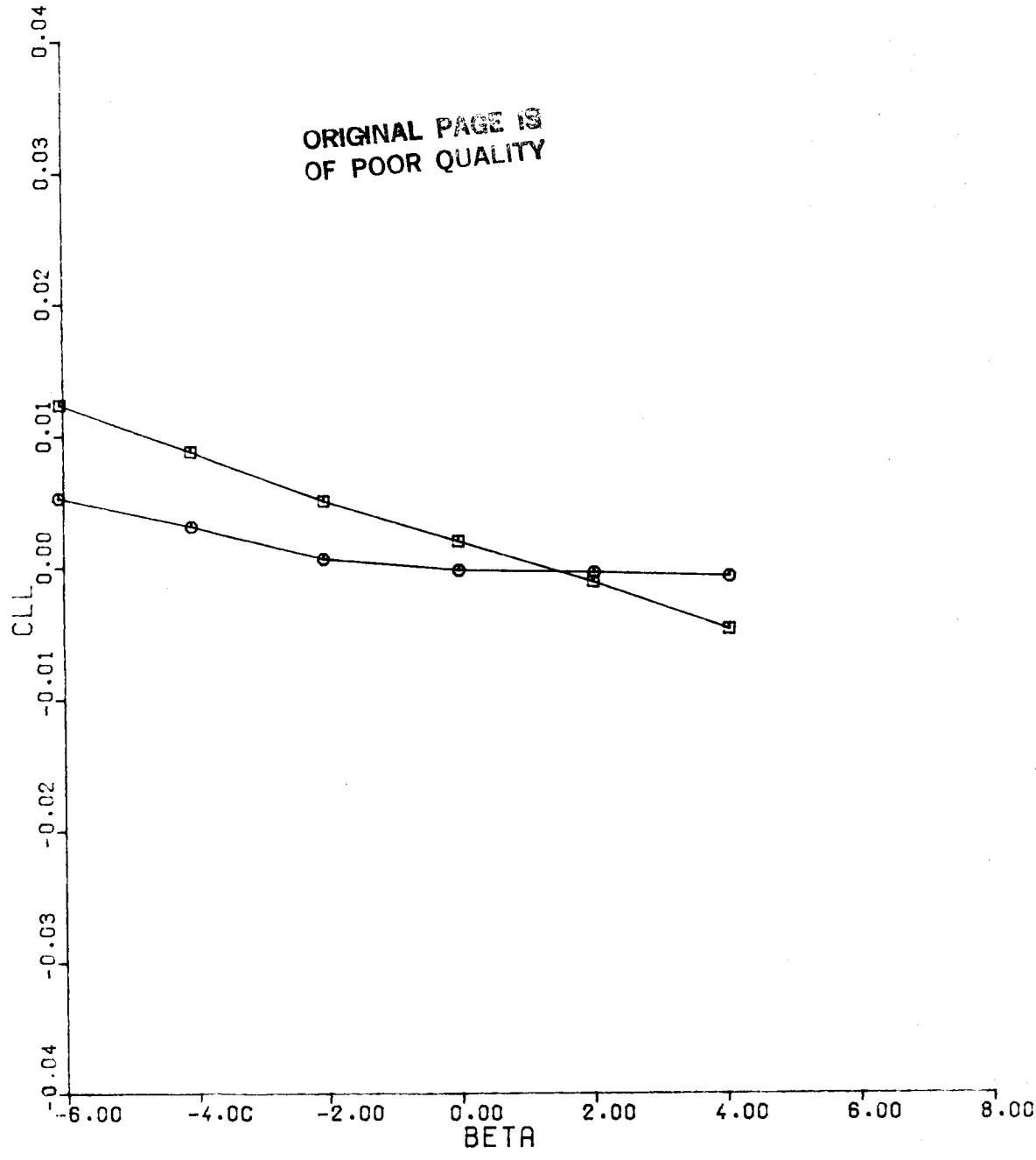

Figure 38(a). CLL vs BETA, DS = 10,
Configuration 2, ALPHA = 11, MACH = 0.9

SYMBOL	RUN	DC
⊡	135	0
⊙	138	-10

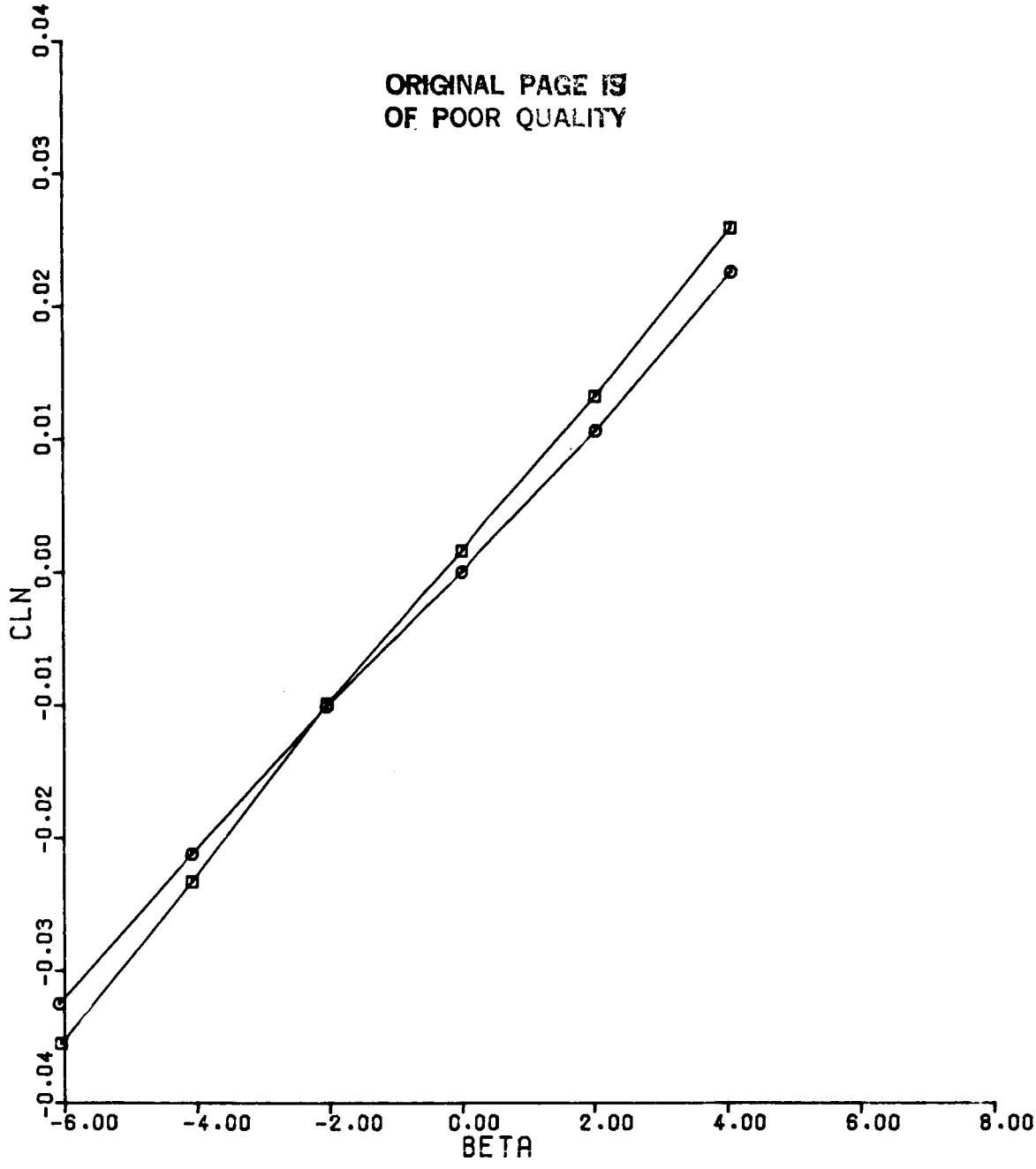

Figure 38(b). CLN vs BETA, DS = 10,
Configuration 2, ALPHA = 11, MACH = 0.9

SYMBOL	RUN	DC
⊡	135	0
⊖	138	-10

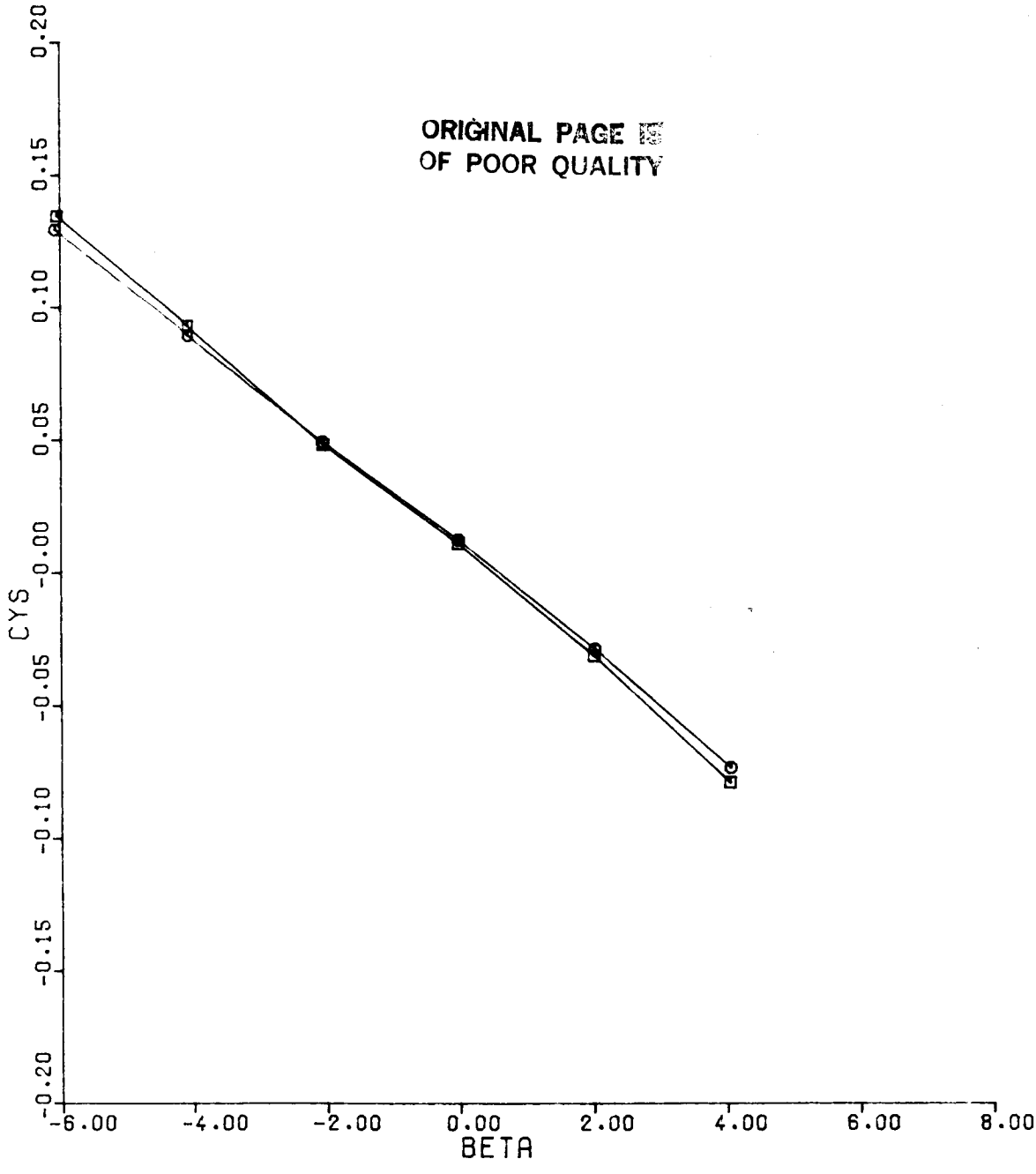

Figure 38(c). CYS vs BETA, DS = 10, Configuration 2, ALPHA = 11, MACH = 0.9

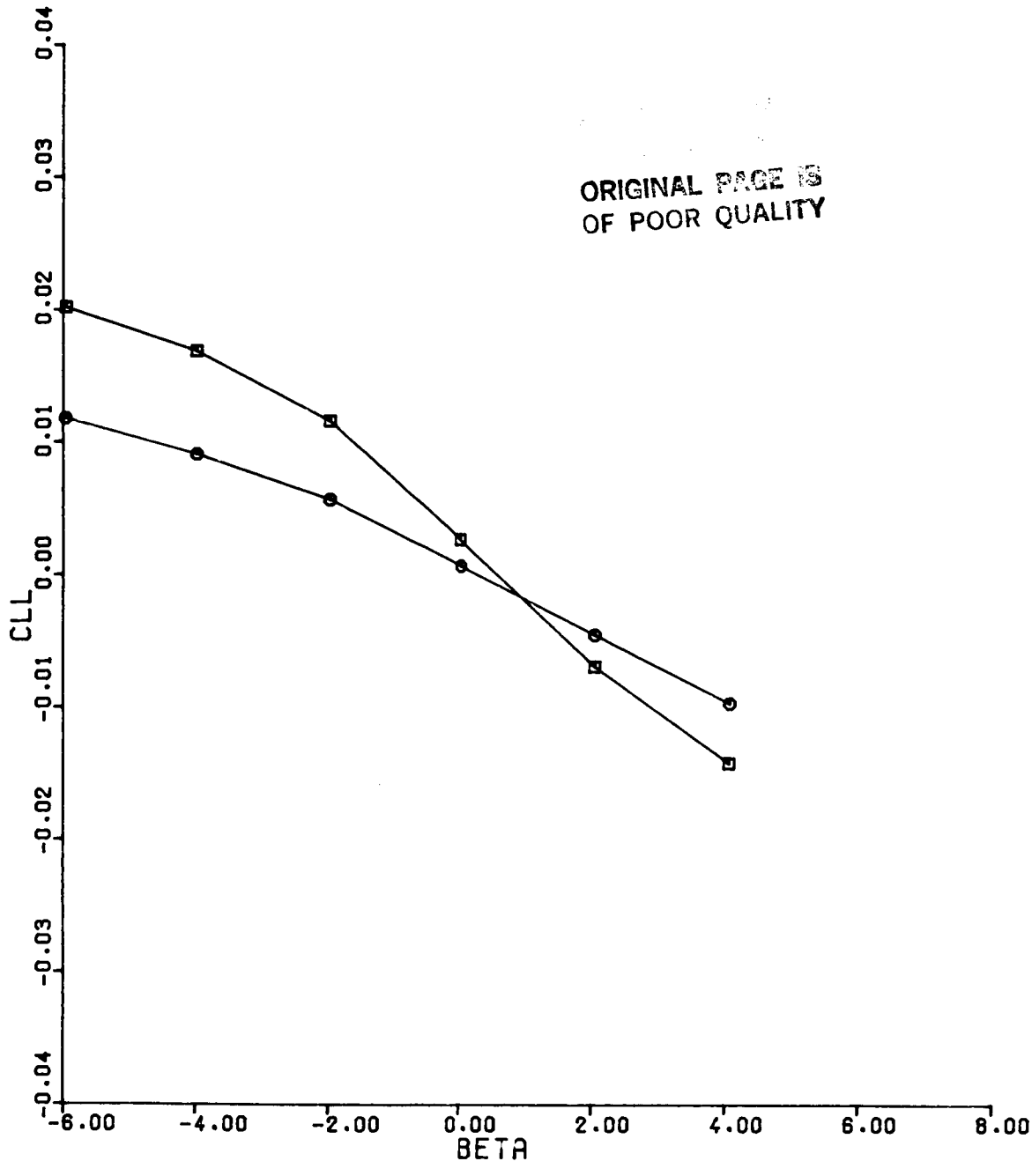

Figure 39(a). CLL vs BETA, DS = 10,
Configuration 2, ALPHA = 16, MACH = 0.9

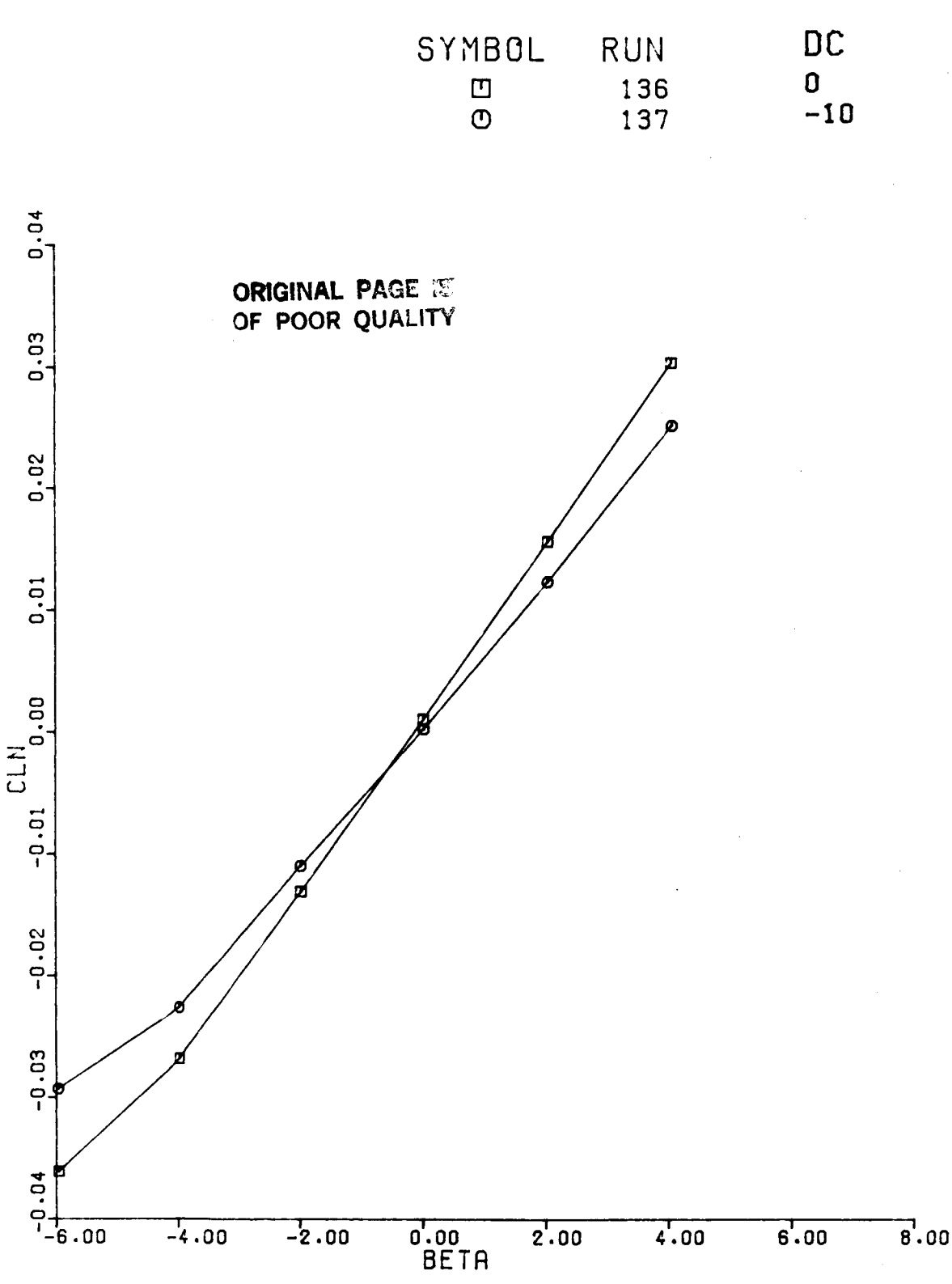

Figure 39(b). CLN vs BETA, DS = 10, Configuration 2, ALPHA = 16, MACH = 0.9

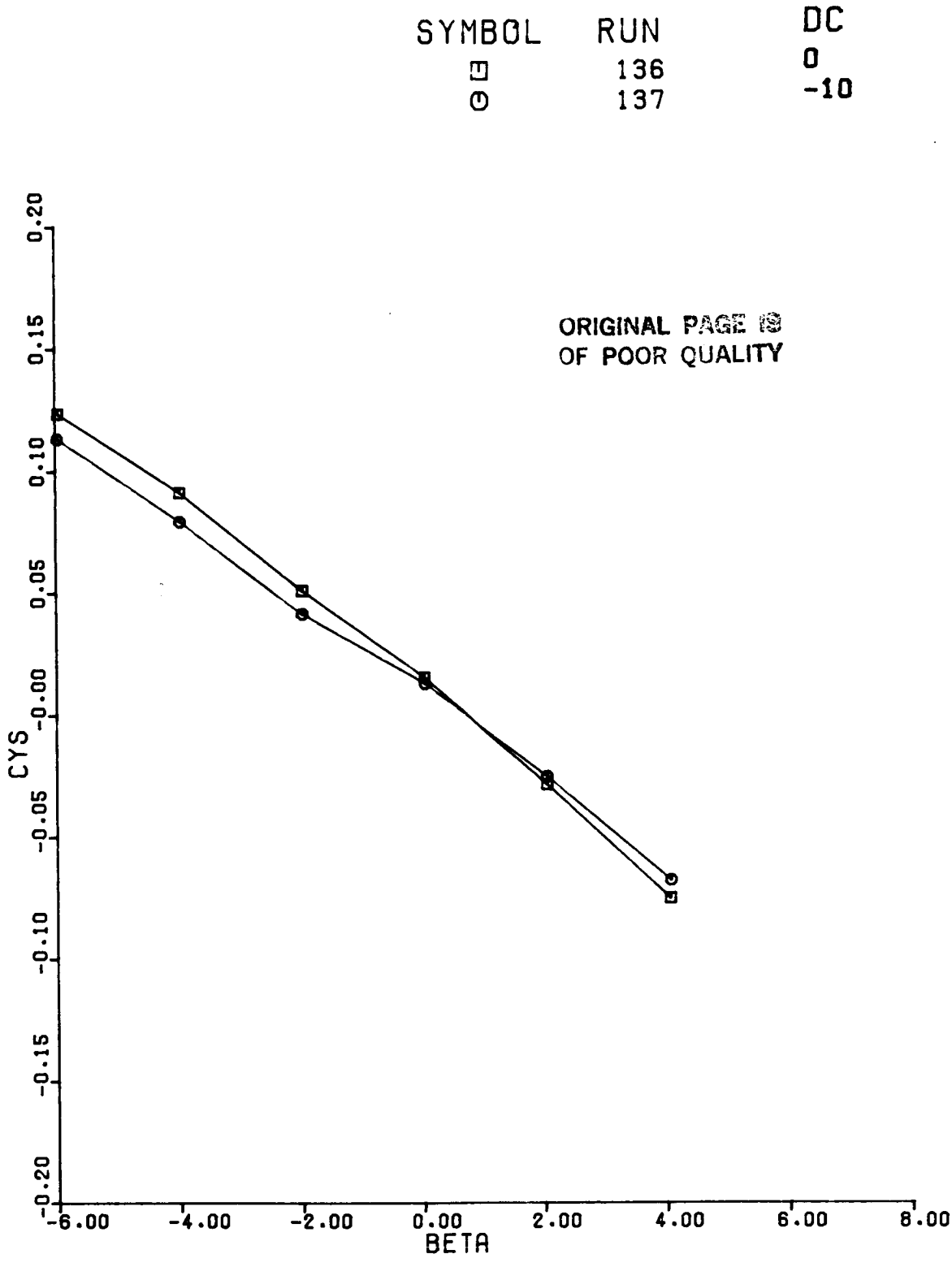

Figure 39(c). CYS vs BETA, DS = 10, Configuration 2, ALPHA = 16, MACH = 0.9

SYMBOL	RUN	DC	ALPHA
⊡	135	0	11
⊙	136	-10	11
⚠	137	0	16
+	138	-10	16

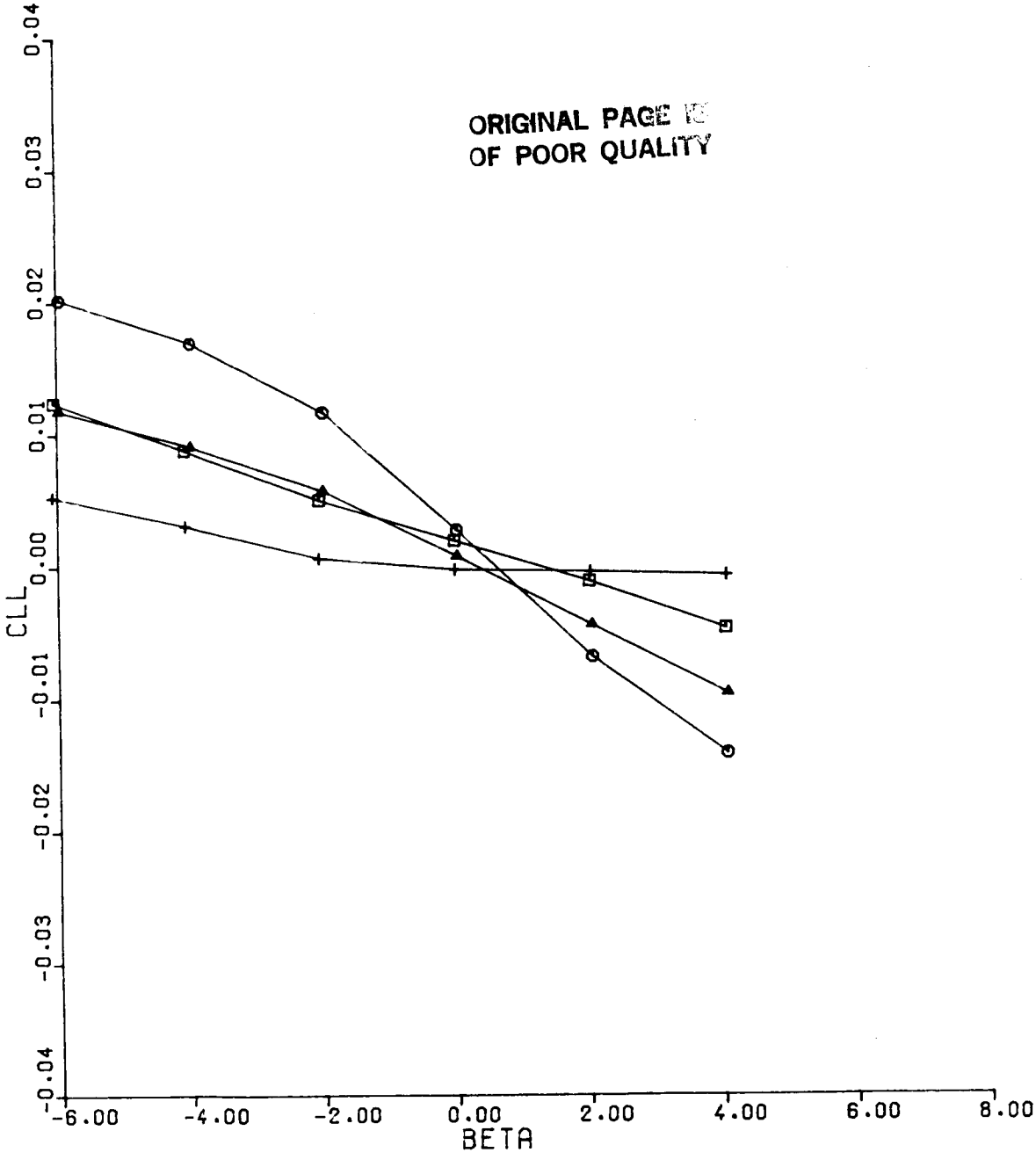

Figure 40(a). CLL vs BETA, DS = 10, Configuration 2, MACH = 0.9

SYMBOL	RUN	DC	ALPHA
□	135	0	11
○	136	-10	11
△	137	0	16
+	138	-10	16

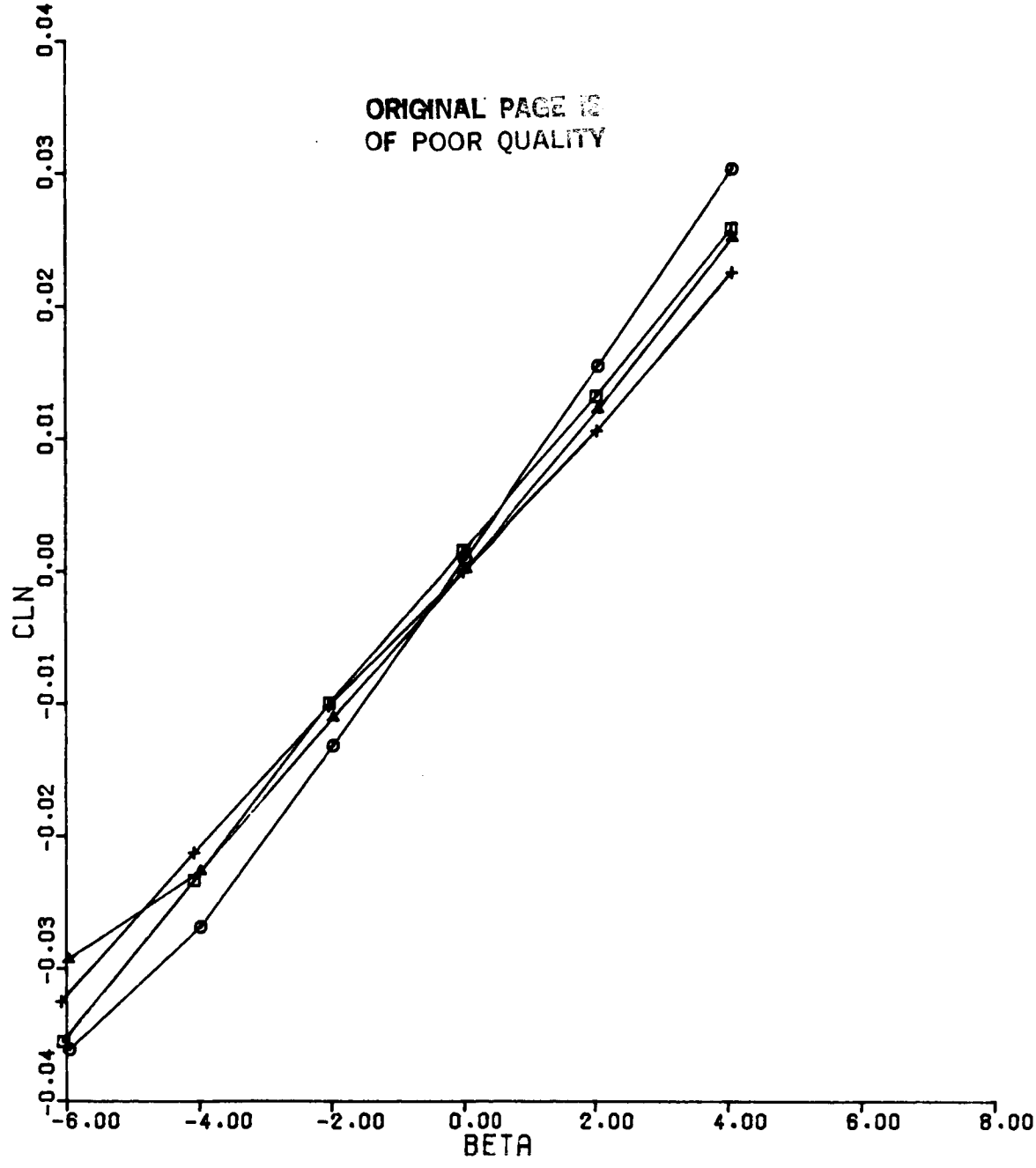

Figure 40(b). CLN vs BETA, DS = 10, Configuration 2, MACH = 0.9

SYMBOL	RUN	DC	ALPHA
□	135	0	11
○	136	-10	11
△	137	0	16
+	138	-10	16

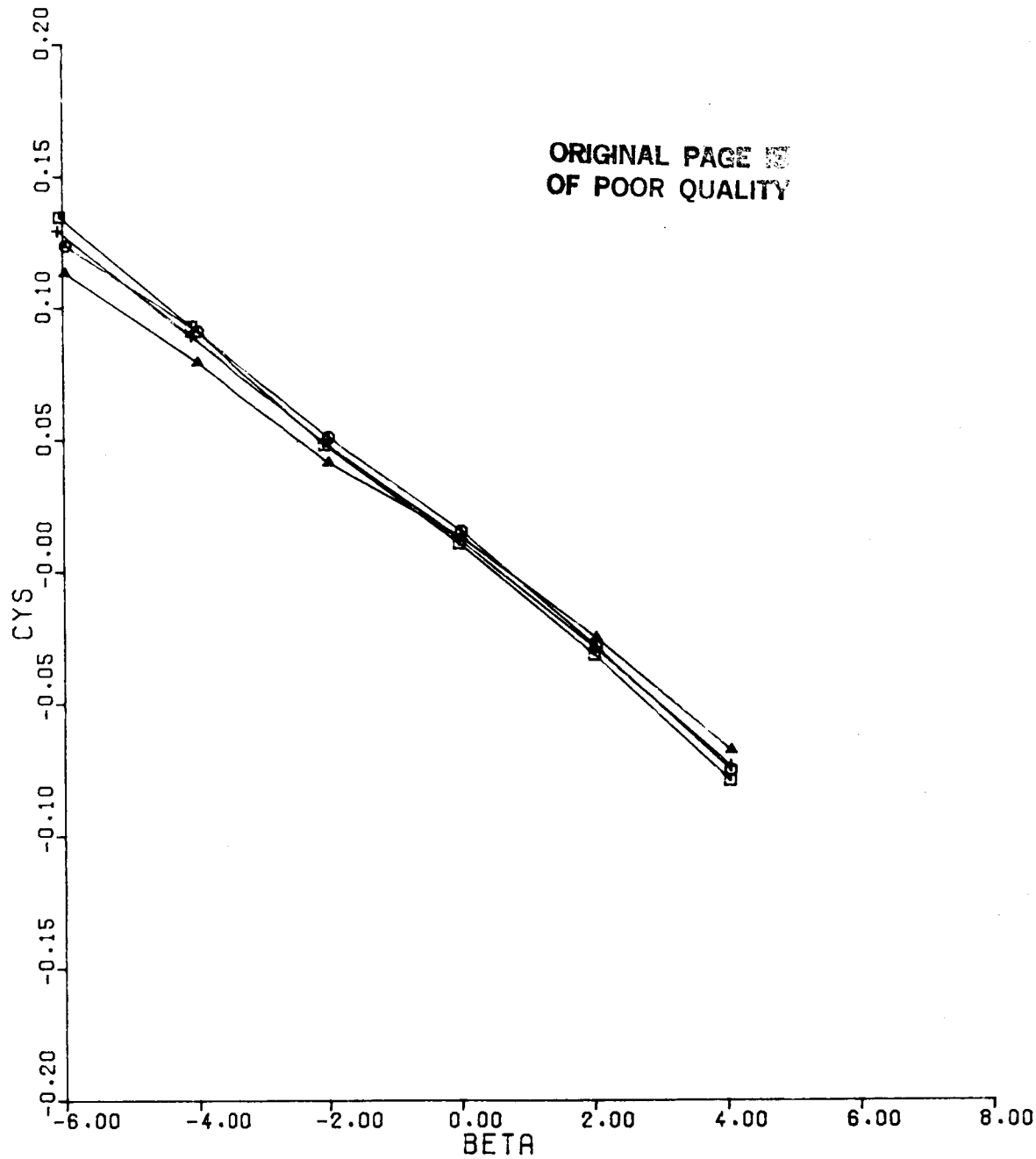

Figure 40(c). CYS vs BETA, DS = 10, Configuration 2, MACH = 0.9

SYMBOL	RUN	DC
□	143	0
○	144	-10
△	145	-20

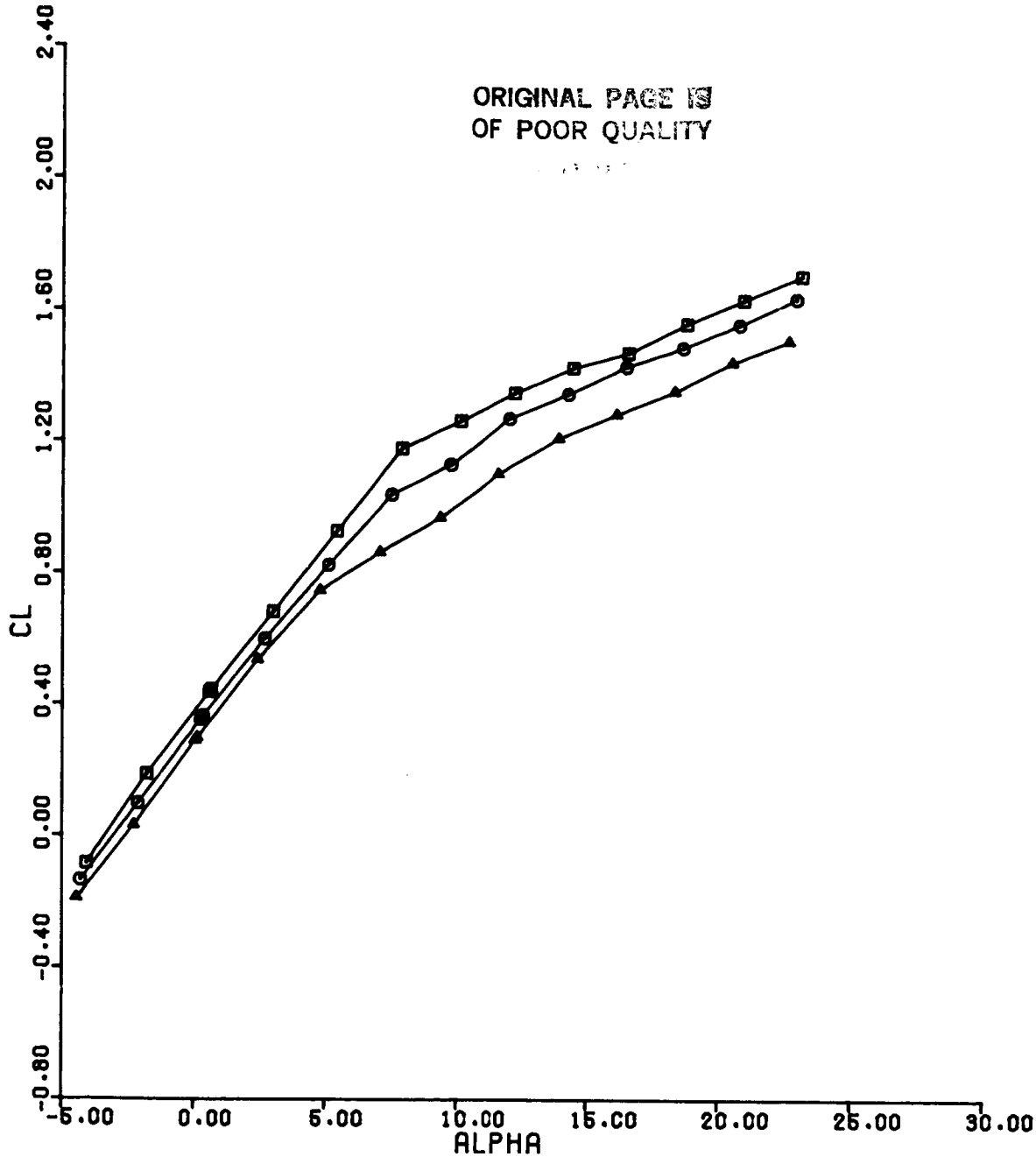

Figure 41(a). CL vs ALPHA, DS = 10, Configuration 3, BETA = 0, MACH = 0.9

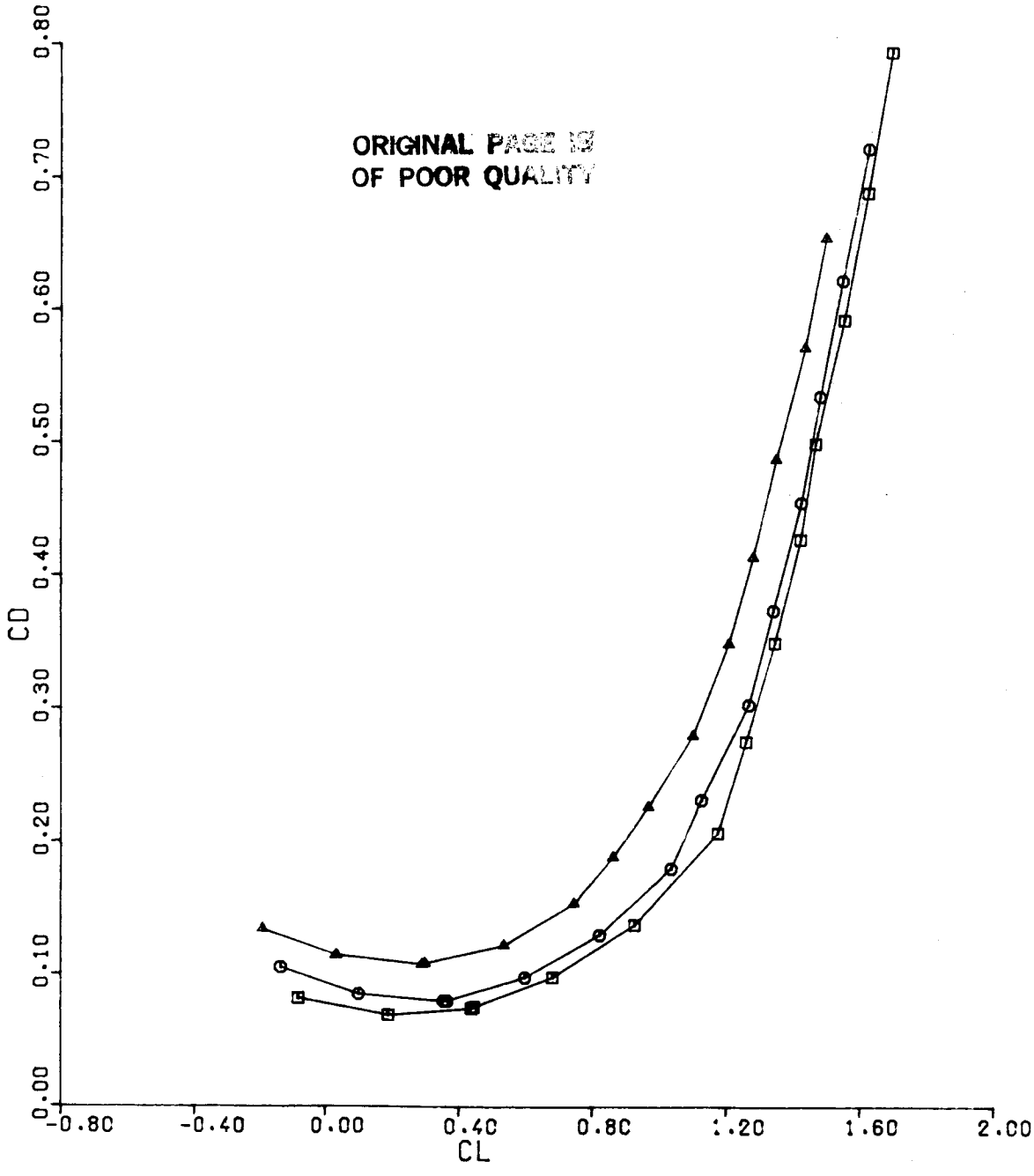

Figure 41(b). CD vs CL, DS = 10, Configuration 3, BETA = 0, MACH = 0.9

SYMBOL	RUN	DC
□	143	0
○	144	-10
△	145	-20

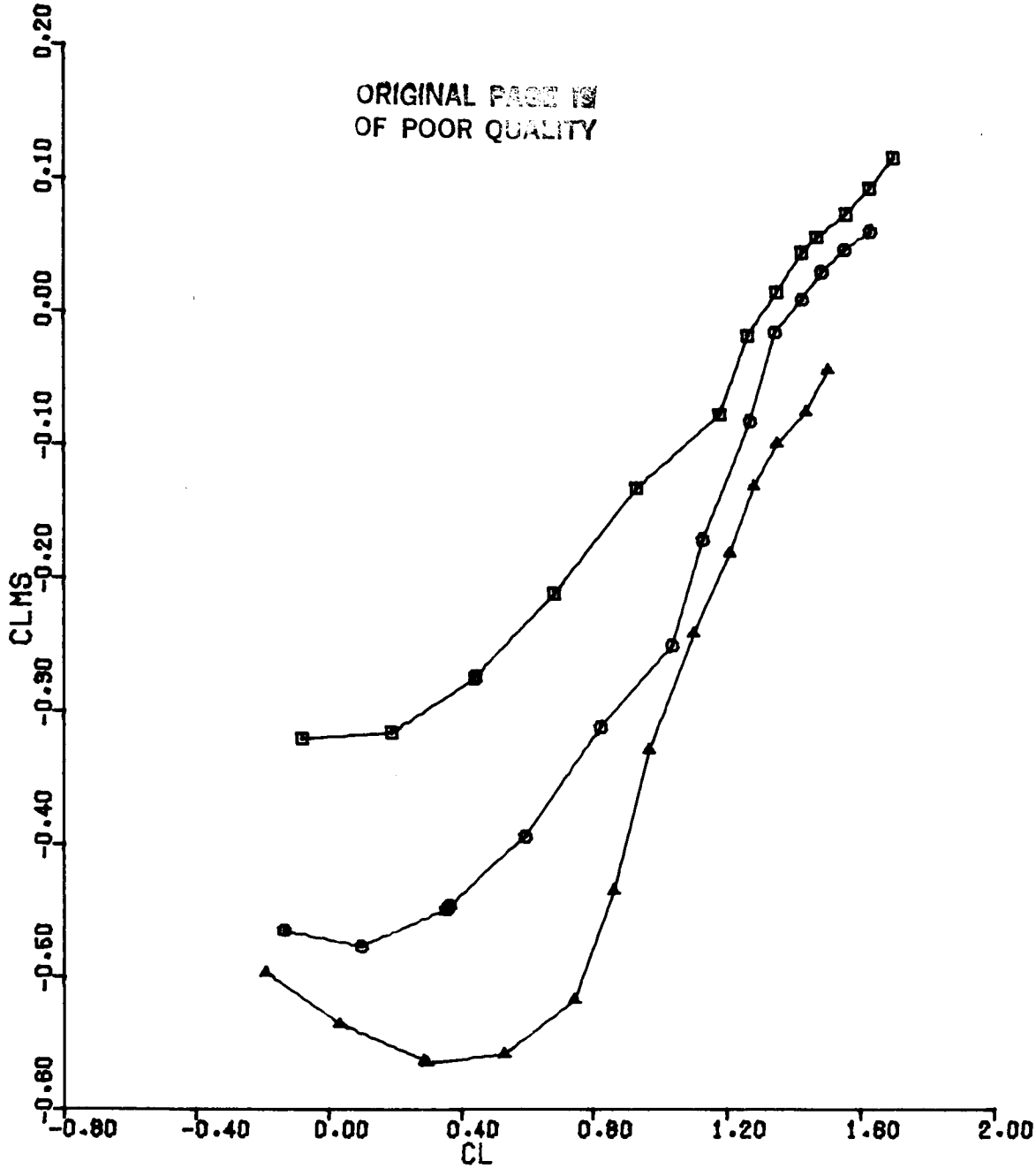

Figure 41(c). CLMS vs CL, DS = 10,
Configuration 3, BETA = 0, MACH = 0.9

SYMBOL	RUN	DC
□	146	-20
○	147	-10
△	148	0

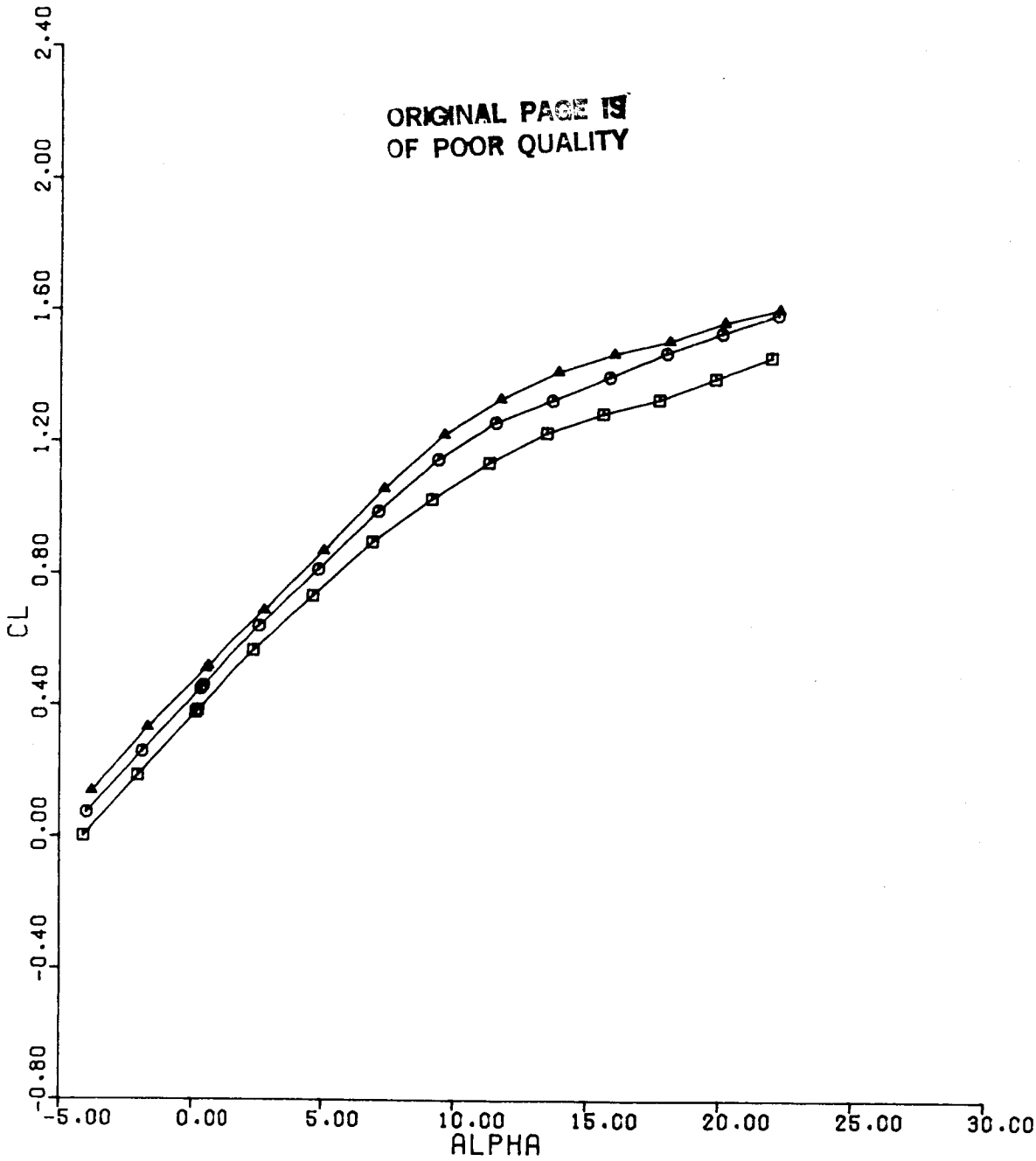

Figure 42(a). CL vs ALPHA, DS = 10, Configuration 3, BETA = 0, MACH = 0.6

SYMBOL	RUN	DC
⊡	146	-20
⊙	147	-10
△	148	0

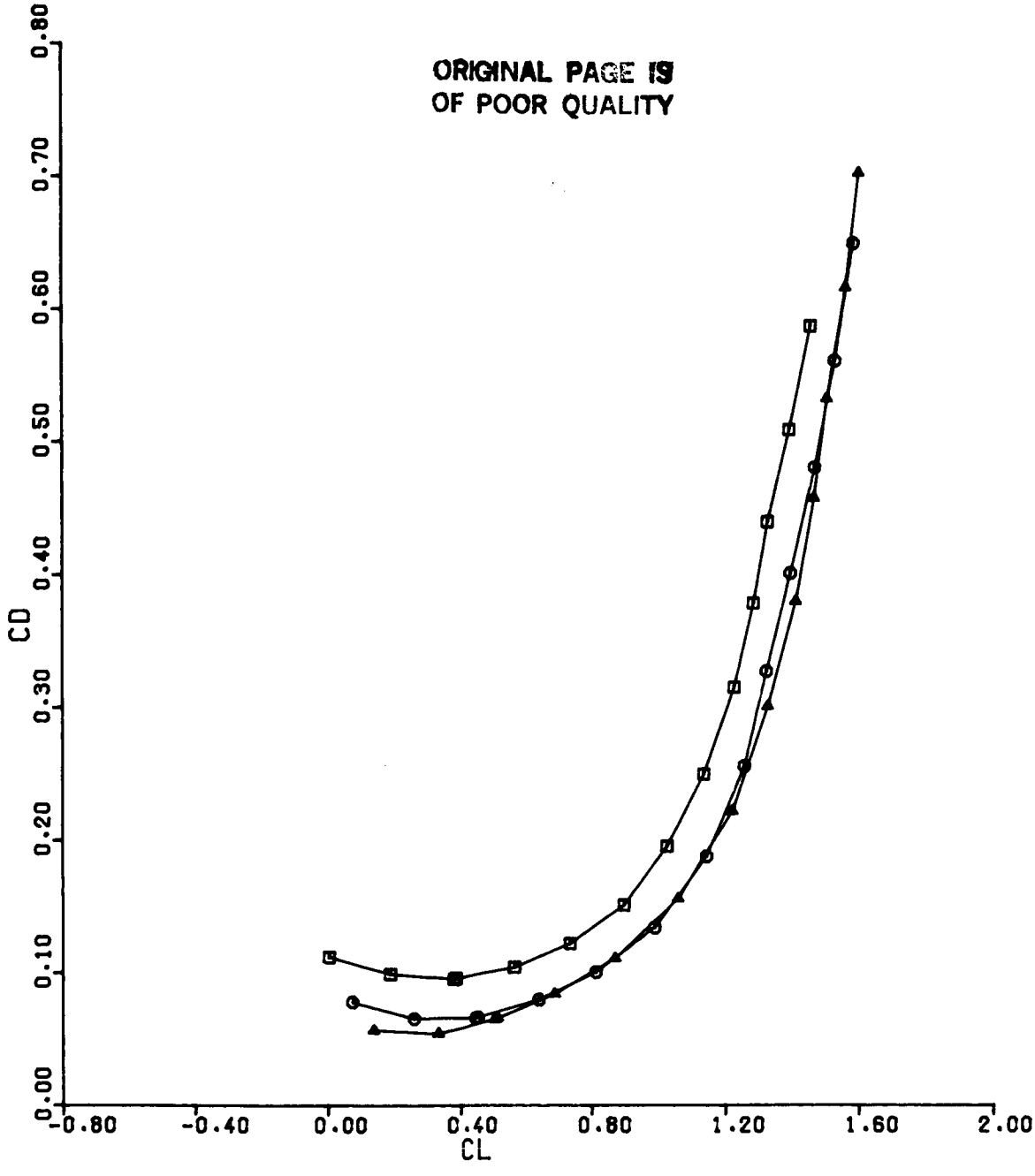

Figure 42(b). CD vs CL, DS = 10,
Configuration 3, BETA = 0, MACH = 0.6

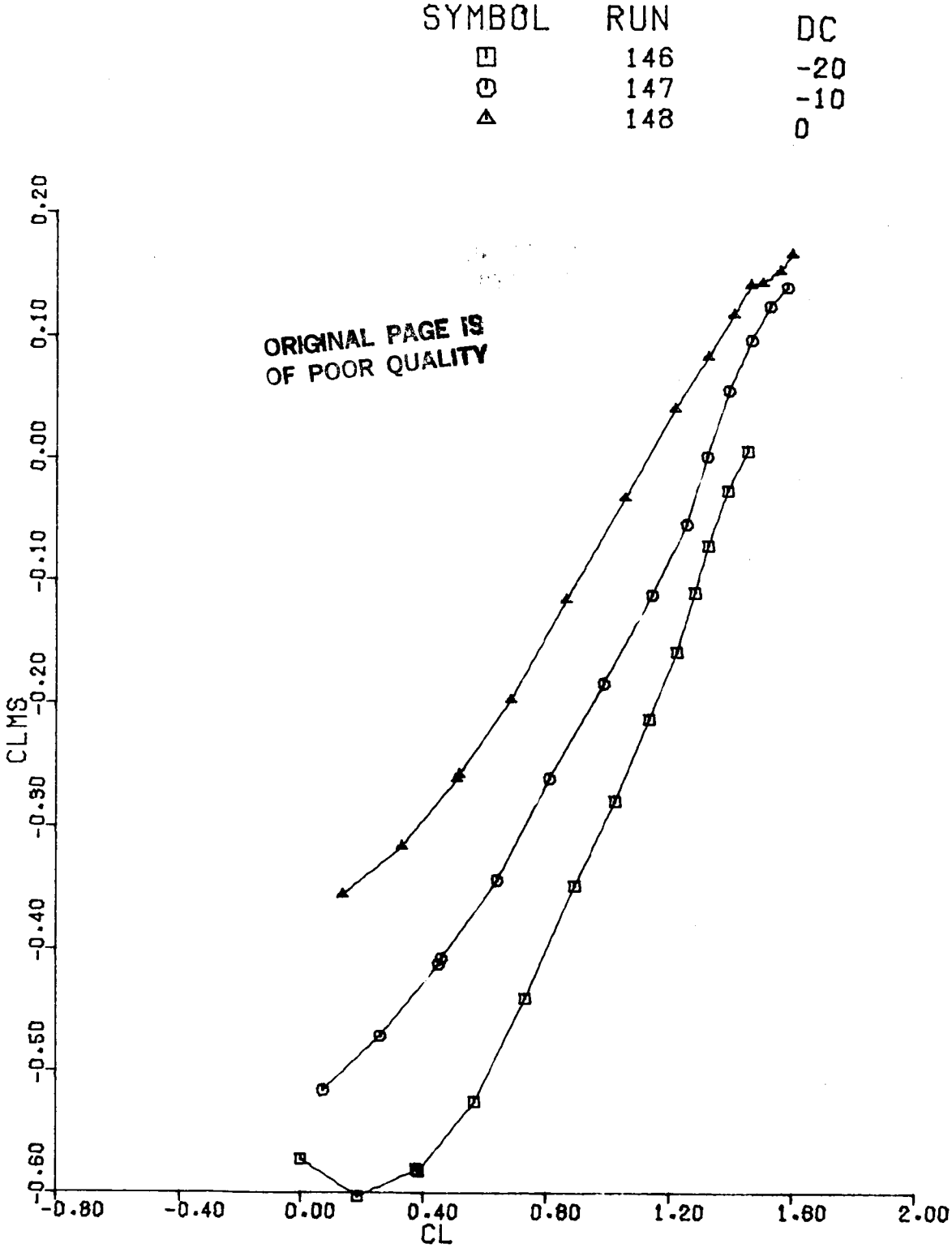

Figure 42(c). CLMS vs CL, DS = 10, Configuration 3, BETA = 0, MACH = 0.6

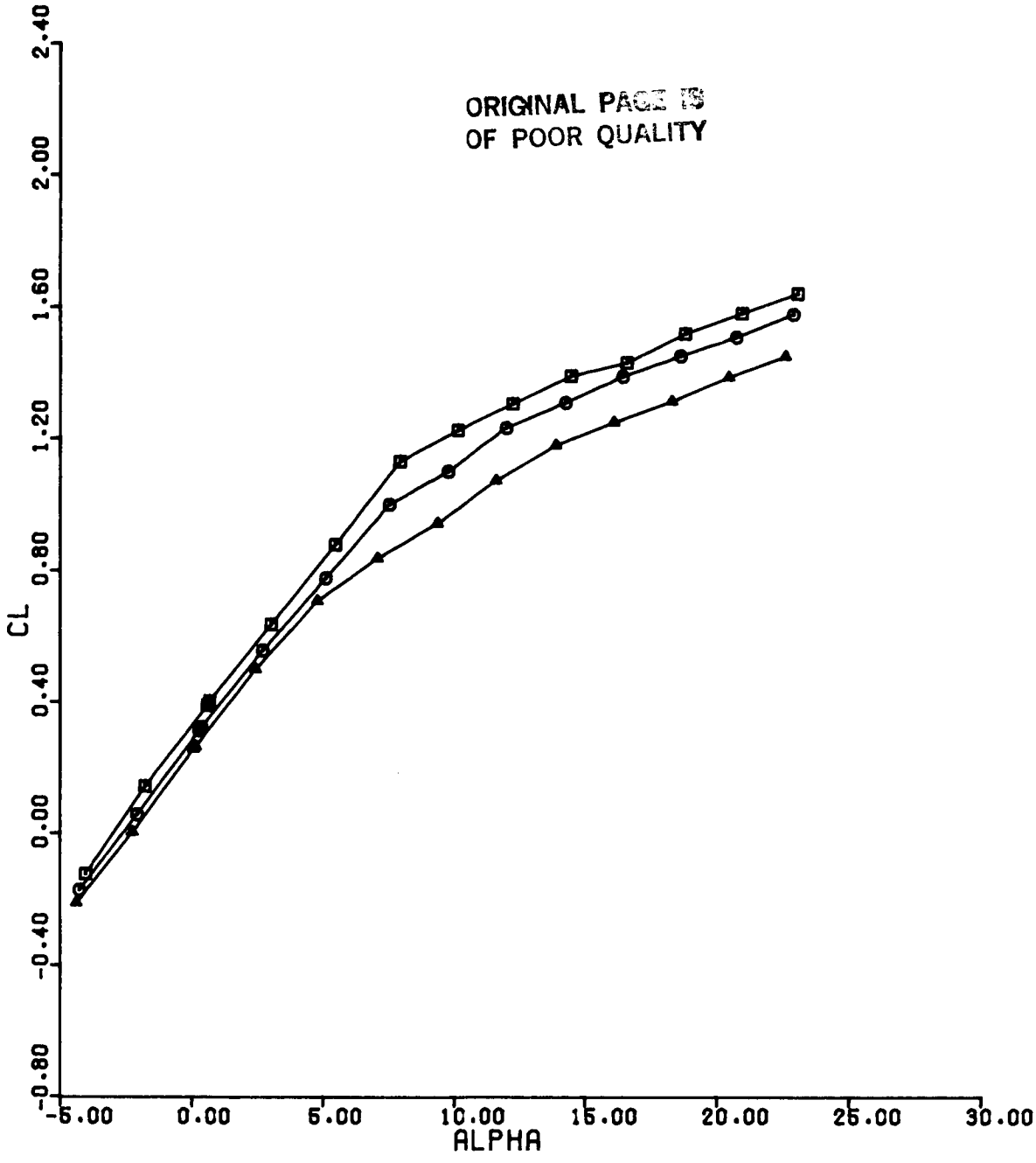

Figure 43(a). CL vs ALPHA, DS = -5, Configuration 3, BETA = 0, MACH = 0.9

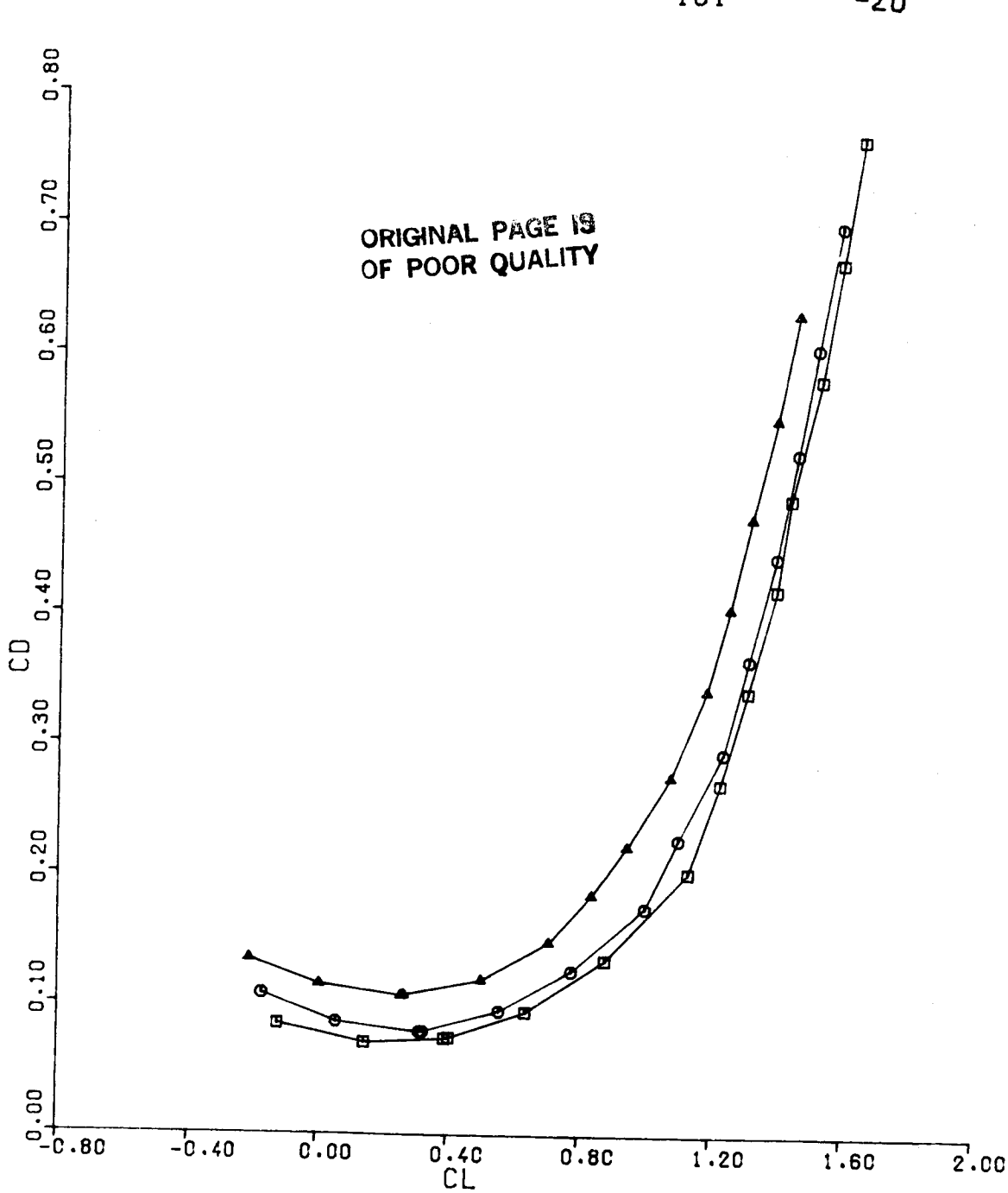

Figure 43(b). CD vs CL, DC = 0,
Configuration 3, BETA = 0, MACH = 0.9

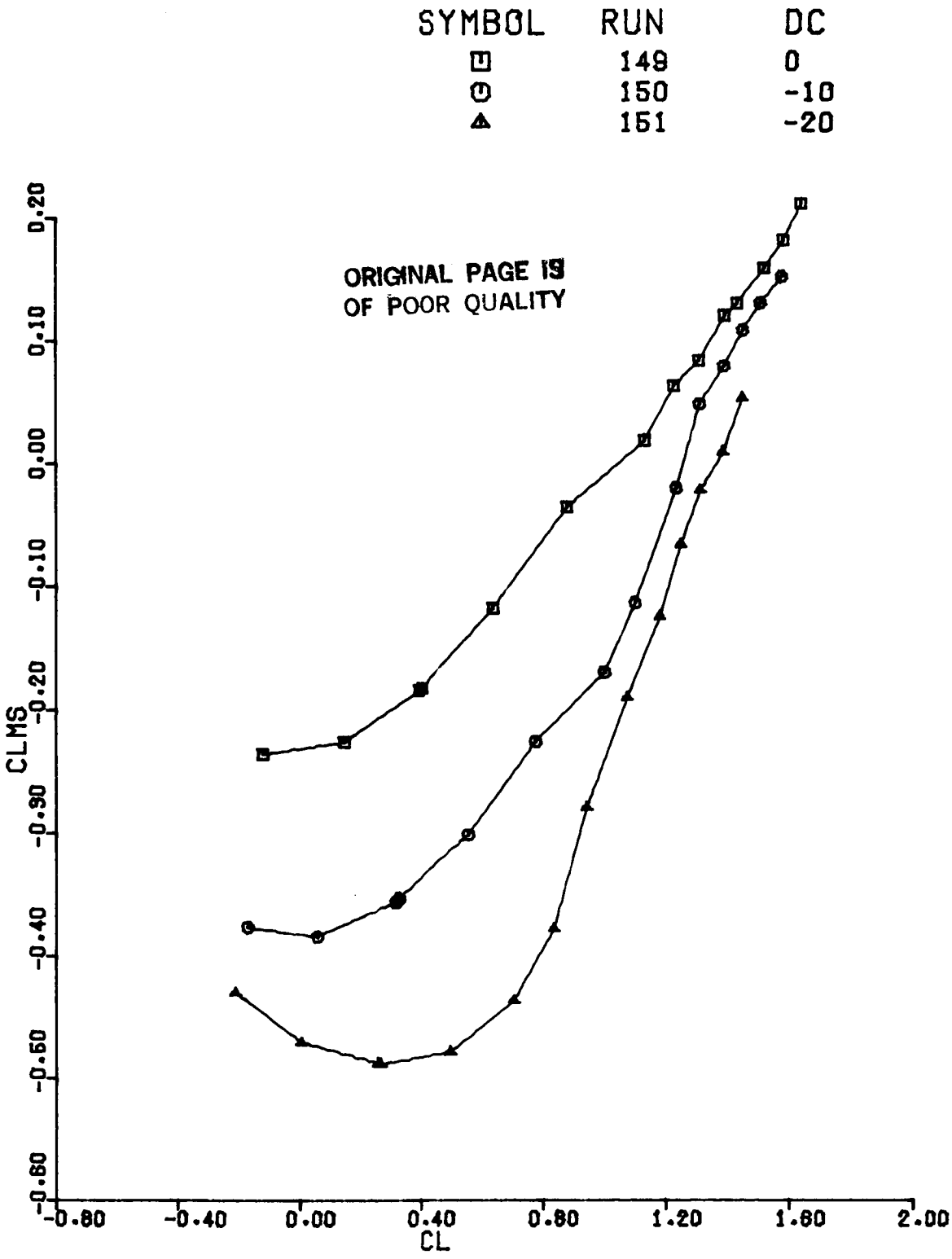

Figure 43(c). CLMS vs CL, DS = -5,
Configuration 3, BETA = 0, MACH = 0.9

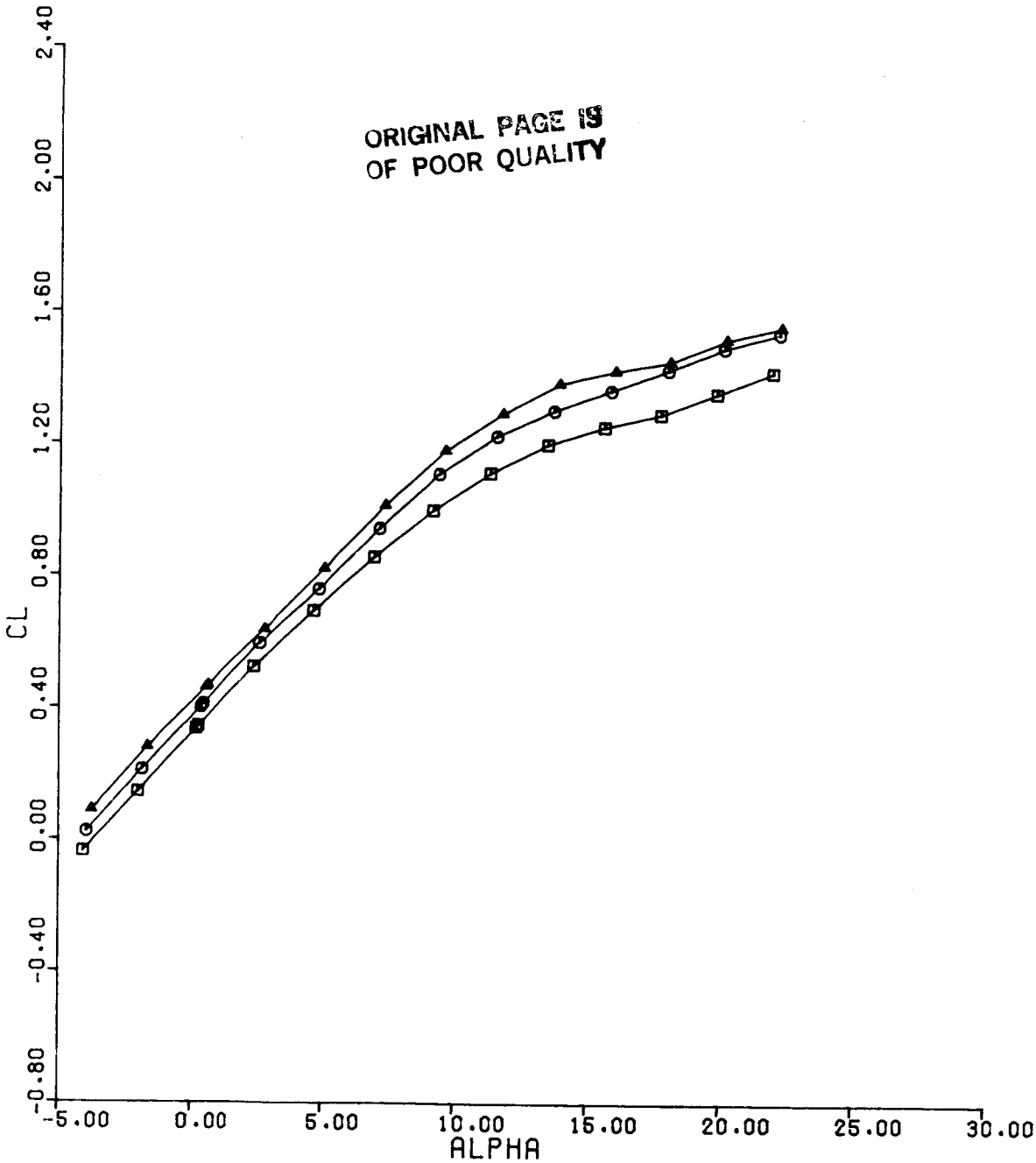

Figure 44(a). CL vs ALPHA, DS = -5, Configuration 3, BETA = 0, MACH = 0.6

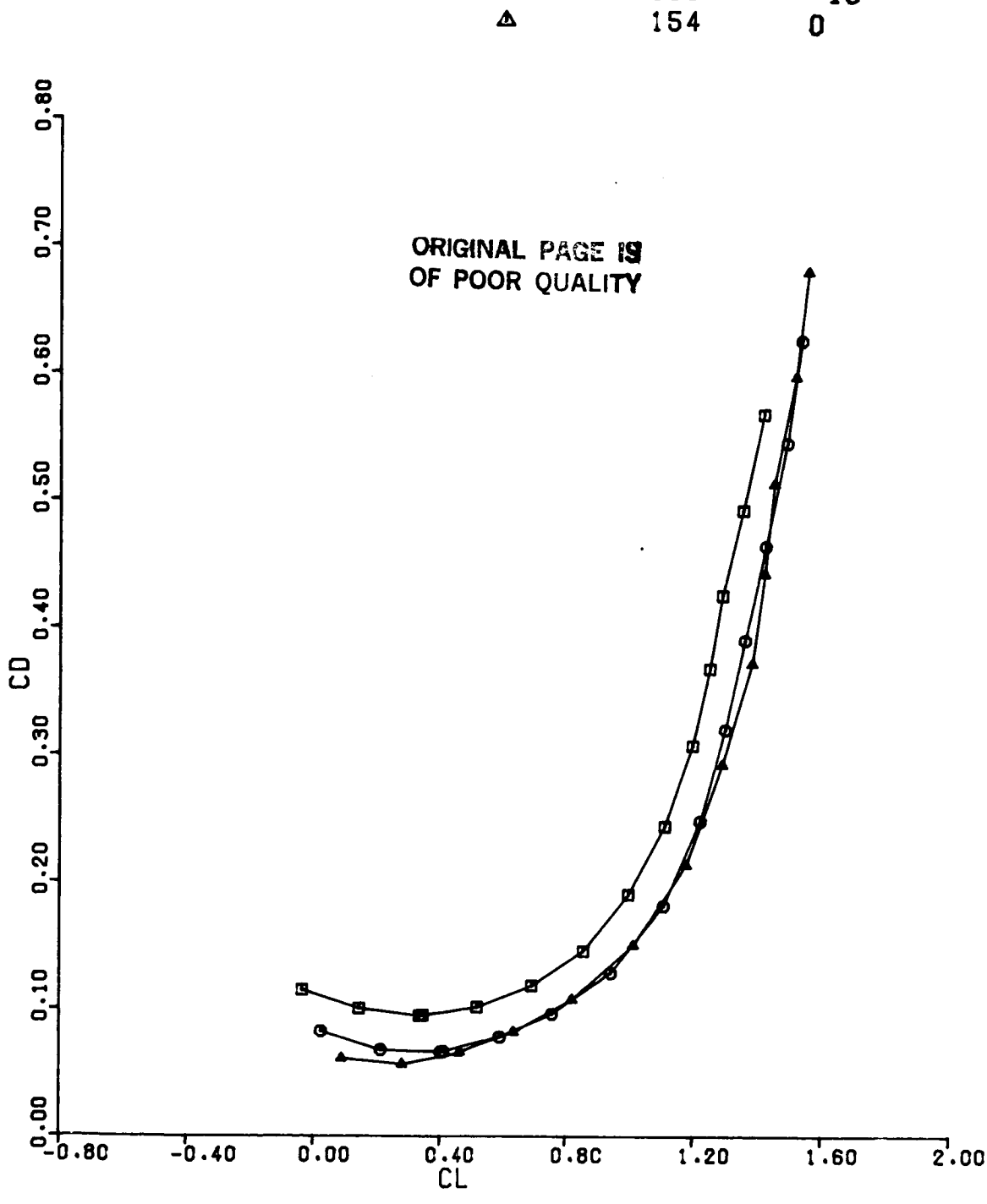

Figure 44(b). CD vs CL, DS = -5,
Configuration 3, BETA = 0, MACH = 0.9

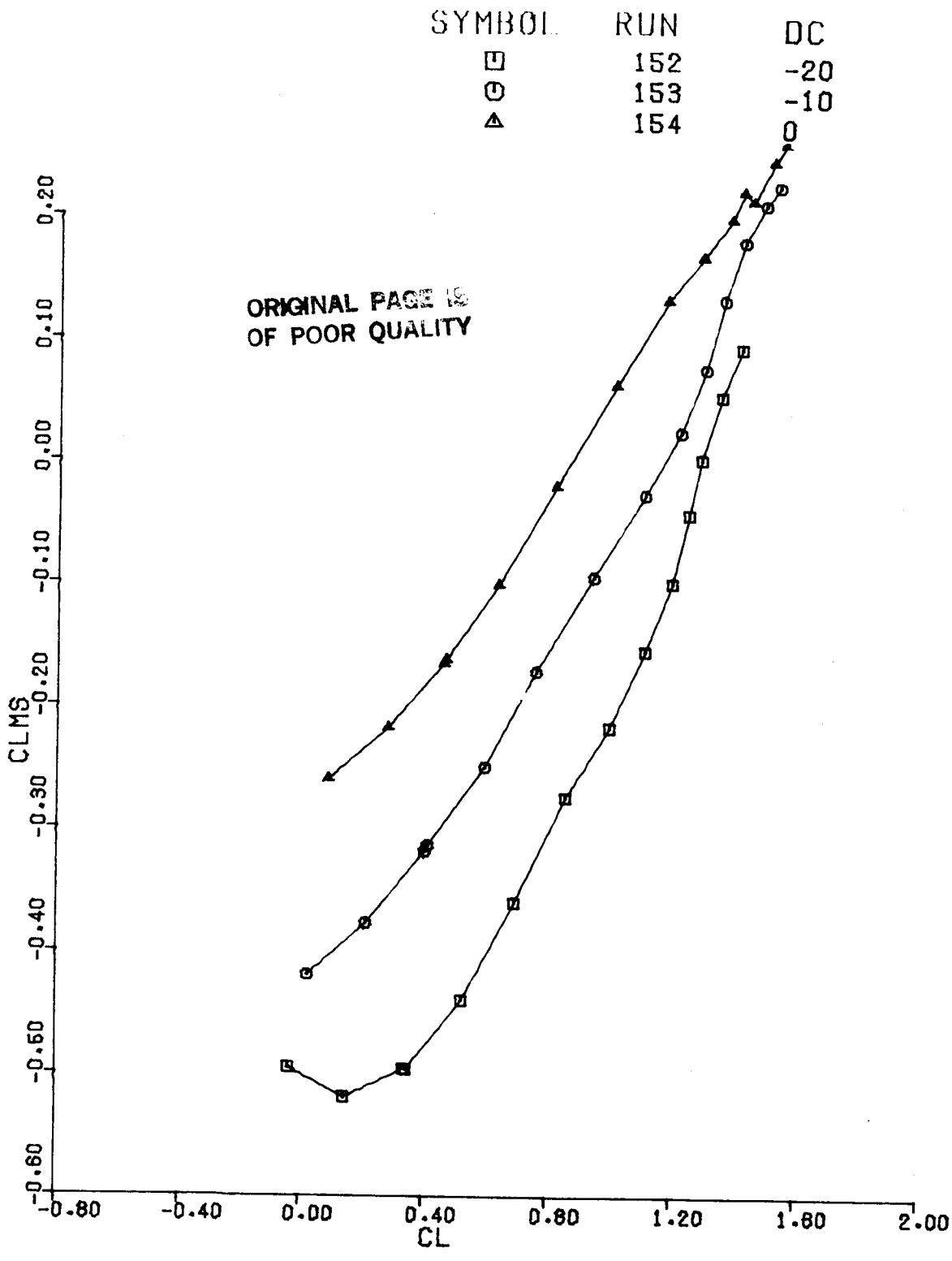

Figure 44(c). CLMS vs CL, DS = -5, Configuration 3, BETA = , MACH = 0.6

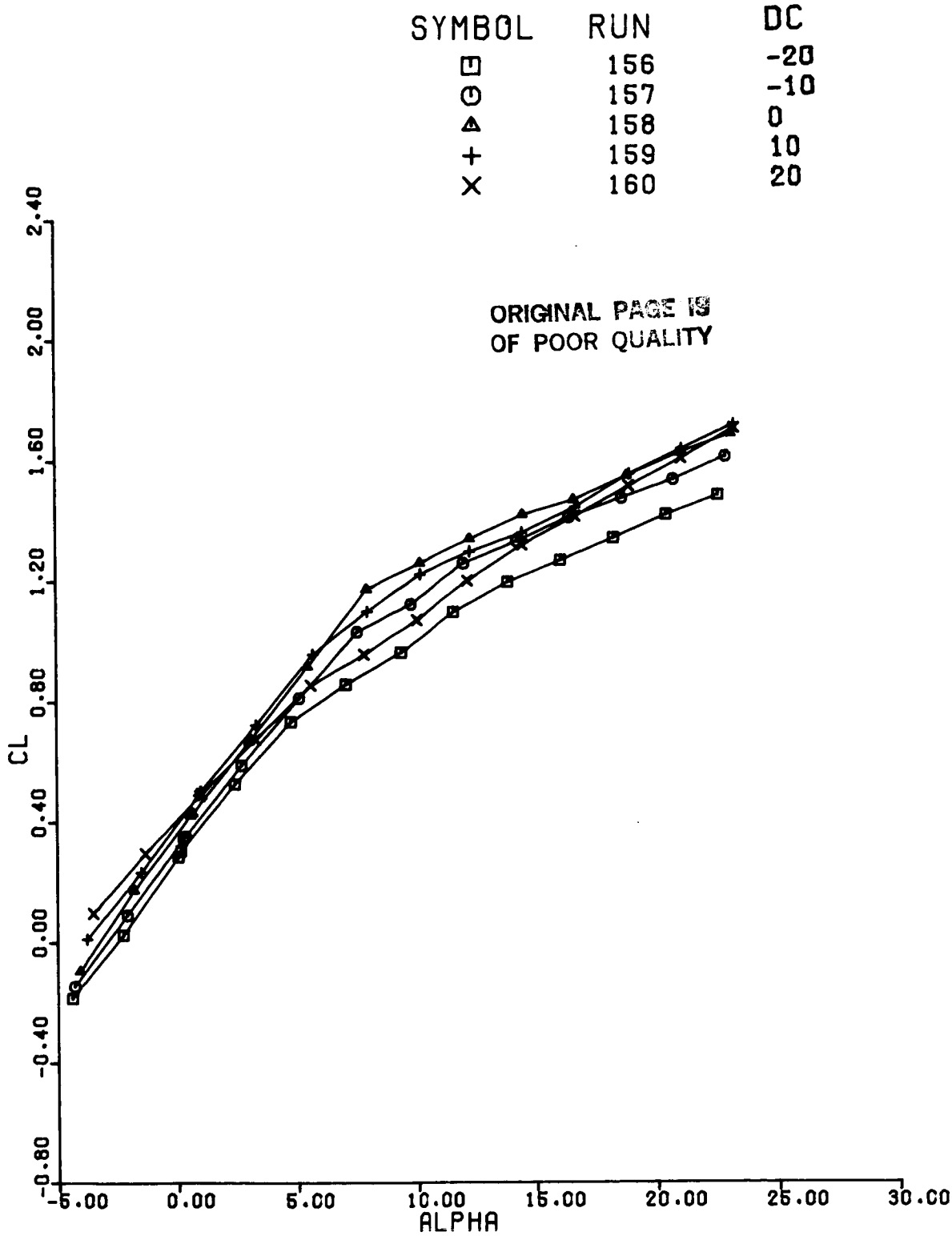

Figure 45(a). CL vs ALPHA, DS = 5, Configuration 3, BETA = 0, MACH = 0.9

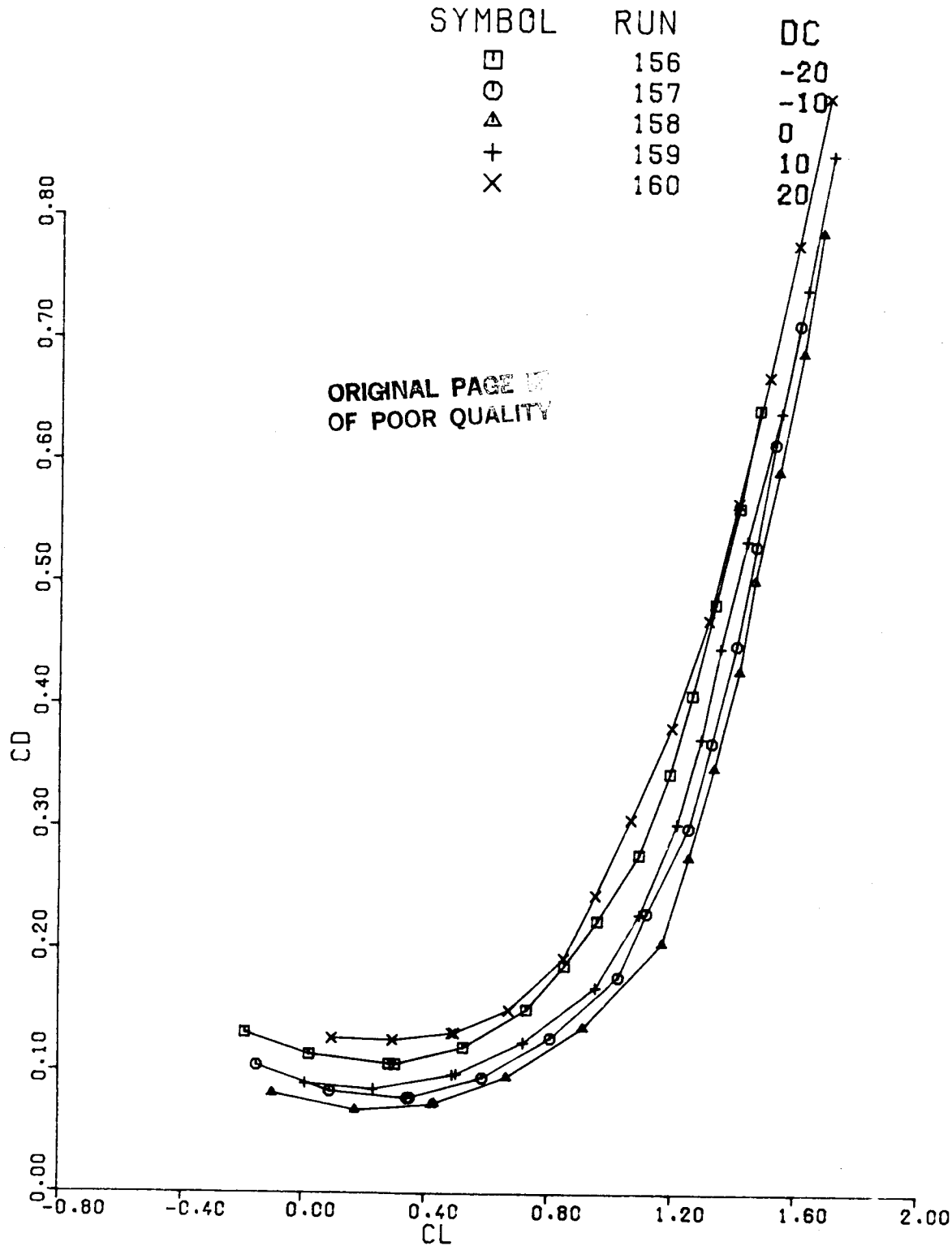

Figure 45(b). CD vs CL, DS = 5,
Configuration 3, BETA = 0, MACH = 0.9

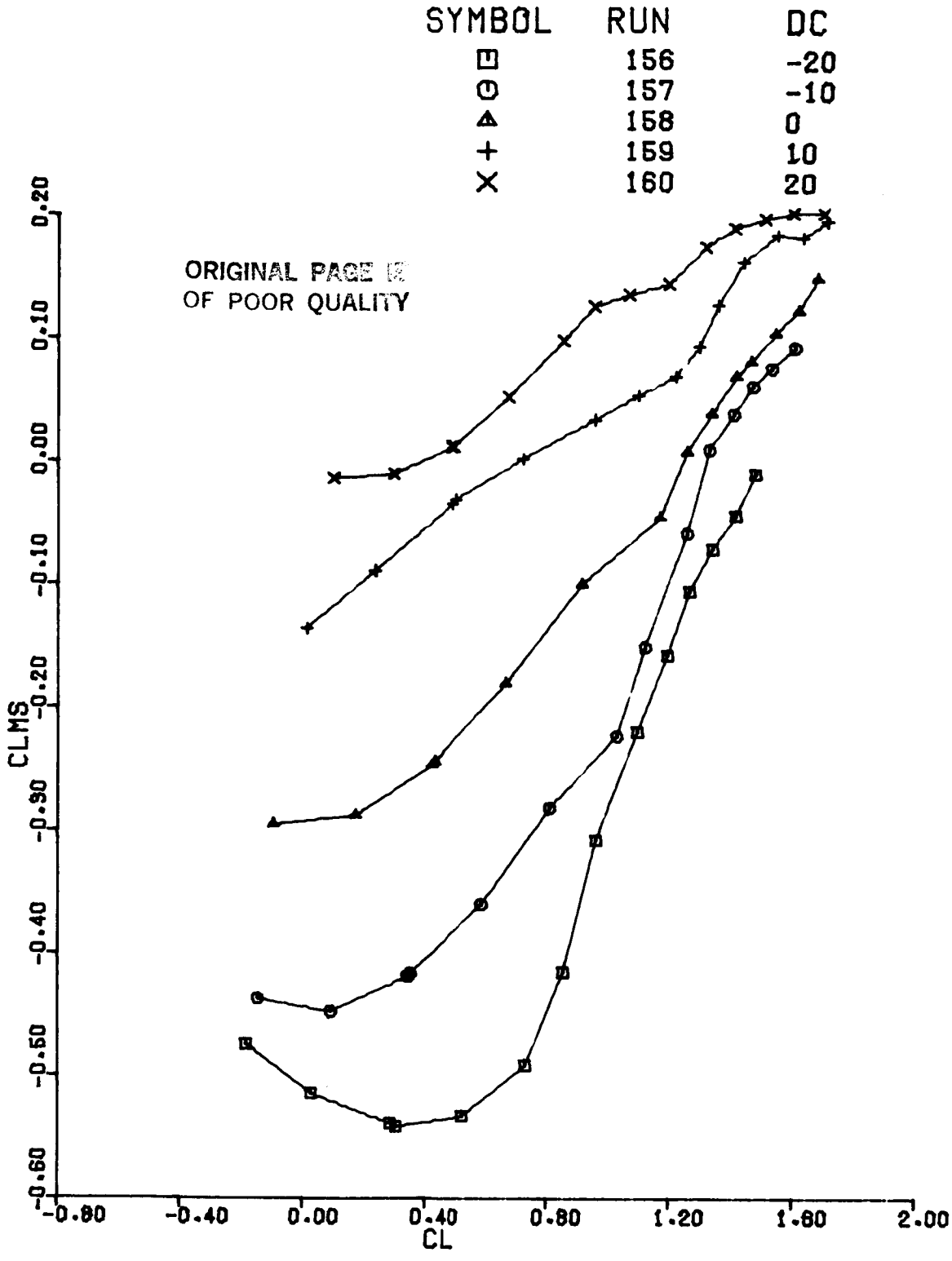

Figure 45(c). CLMS vs CL, DS = 5,
Configuration 3, BETA = 0, MACH = 0.9

SYMBOL	RUN	DC
□	161	20
○	162	10
△	163	0
+	164	-10
×	165	-20

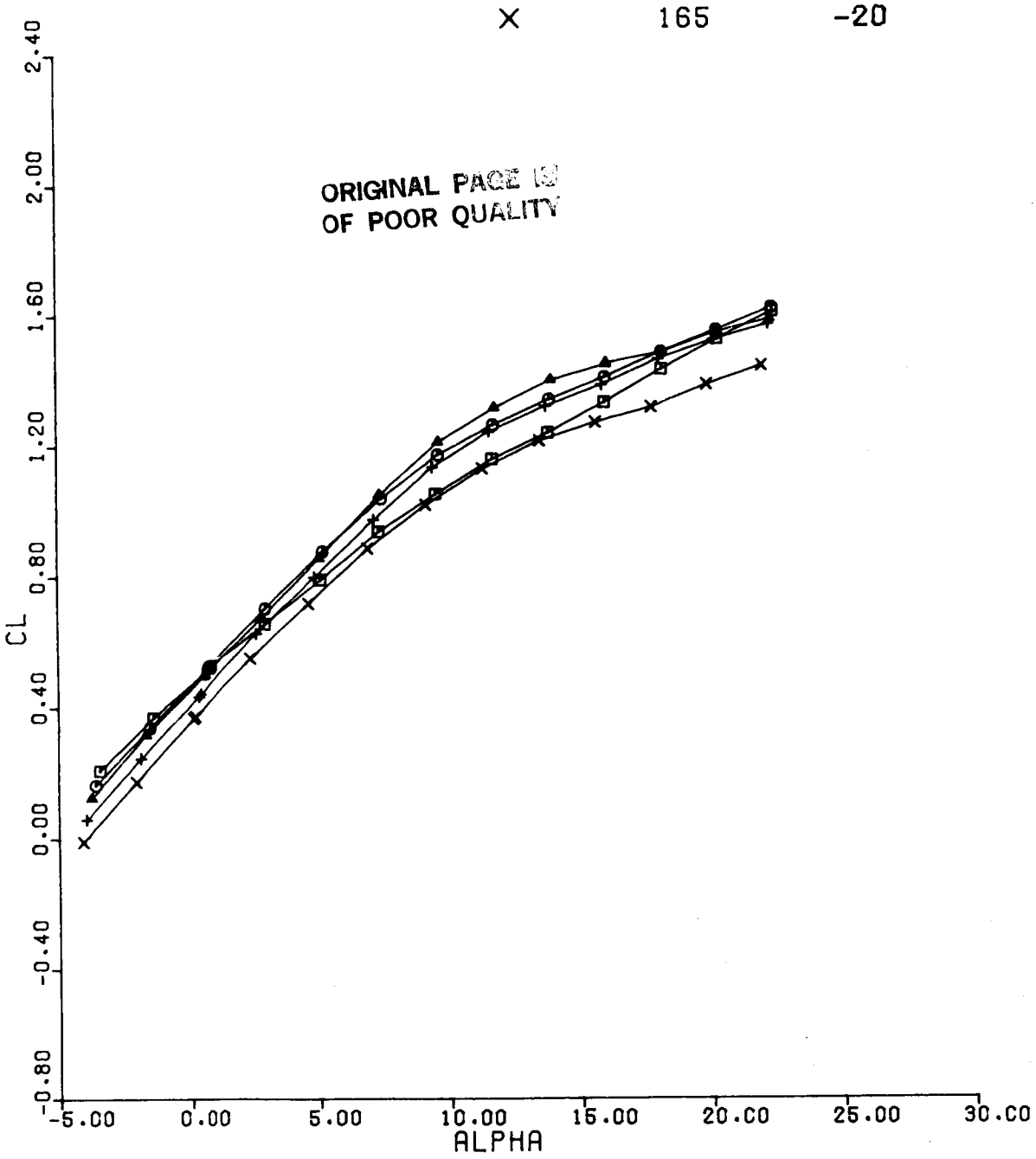

Figure 46(a). CL vs ALPHA, DS = 5, Configuration 3, BETA = 0, MACH = 0.6

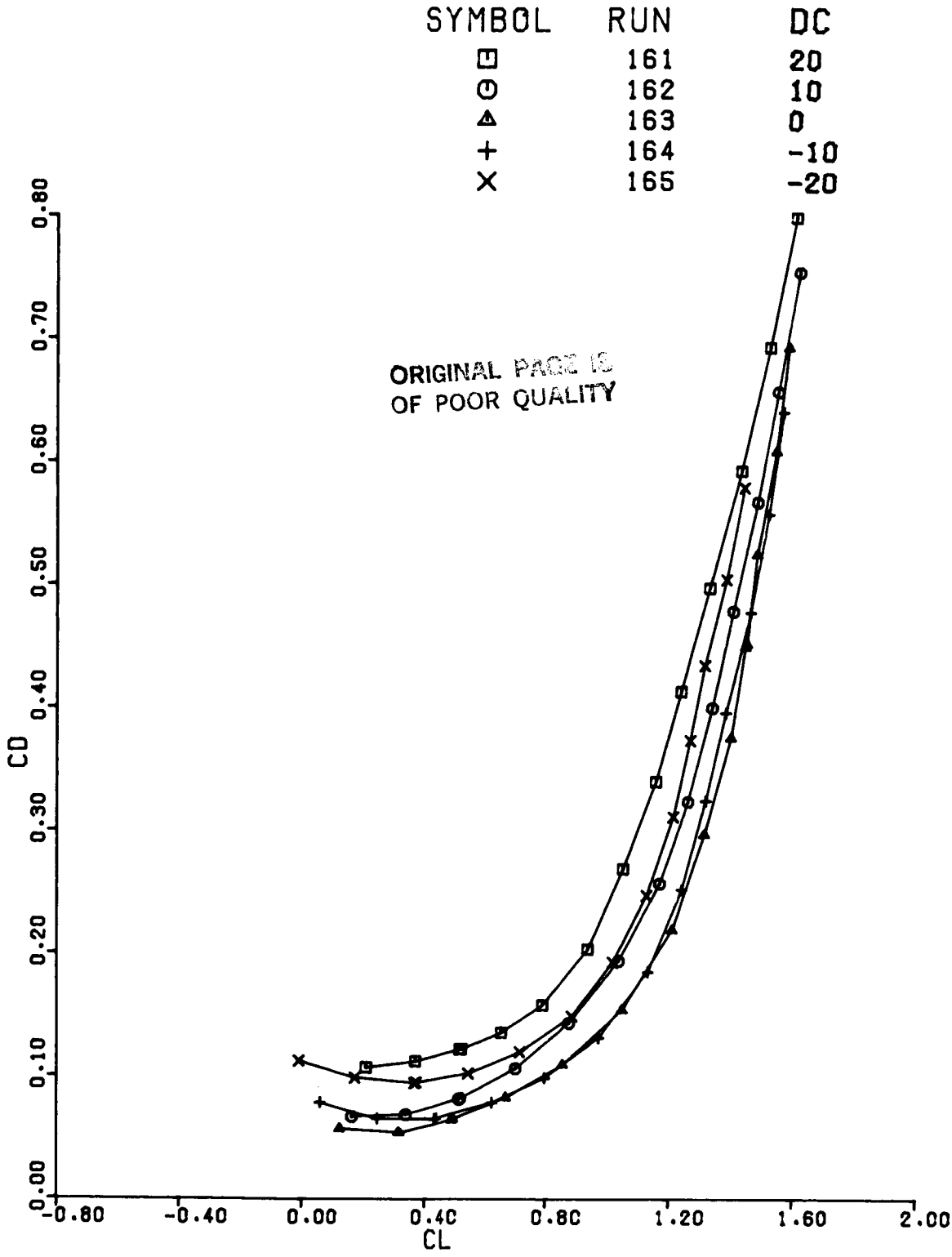

Figure 46(b). CD vs CL, DS = 5,
Configuration 3, BETA = 0, MACH = 0.6

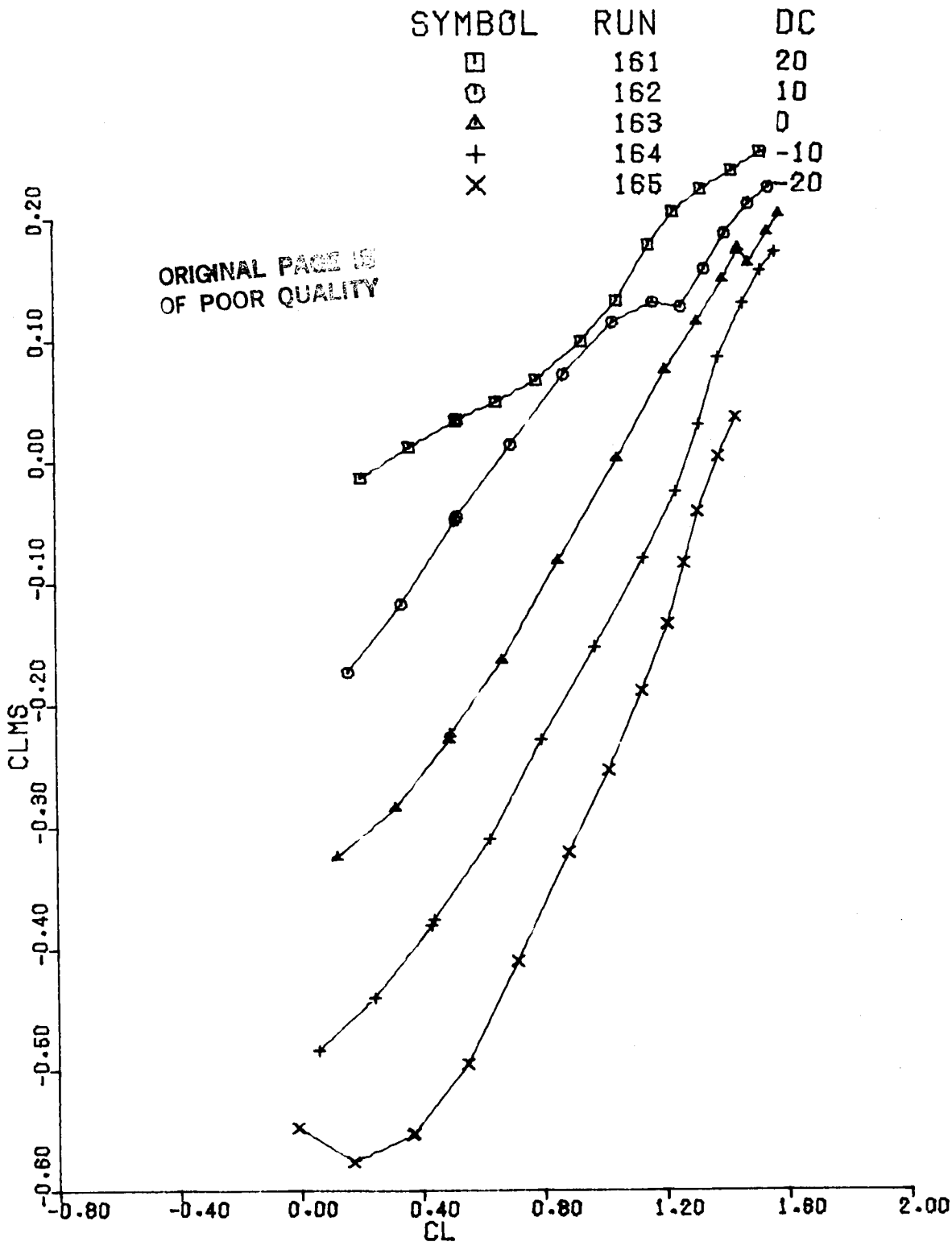

Figure 46(c). CLMS vs CL, DS = 5, Configuration 3, BETA = 0, MACH = 0.6

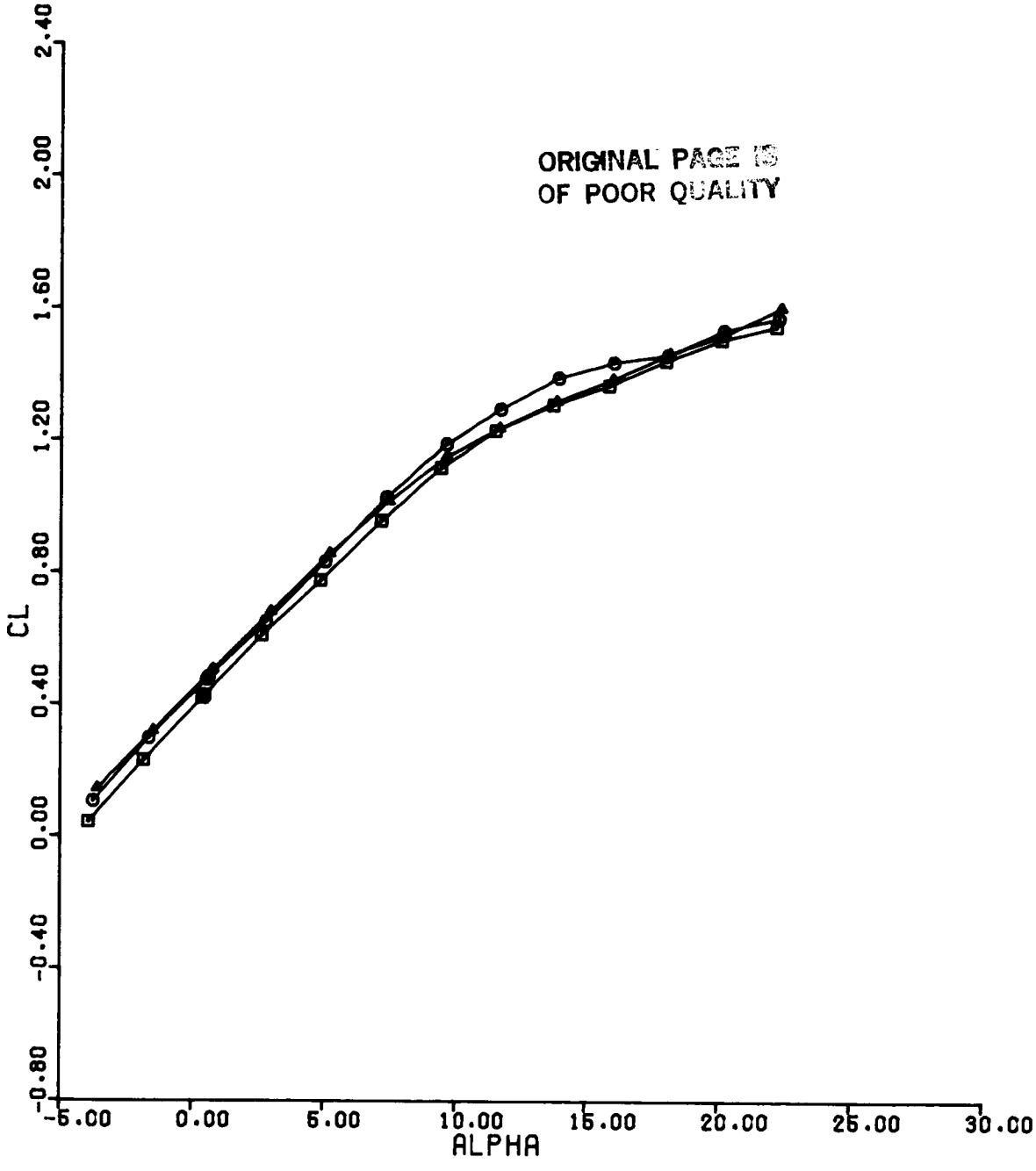

Figure 47(a). CL vs ALPHA, DS = 0, Configuration 3, BETA = 0, MACH = 0.6

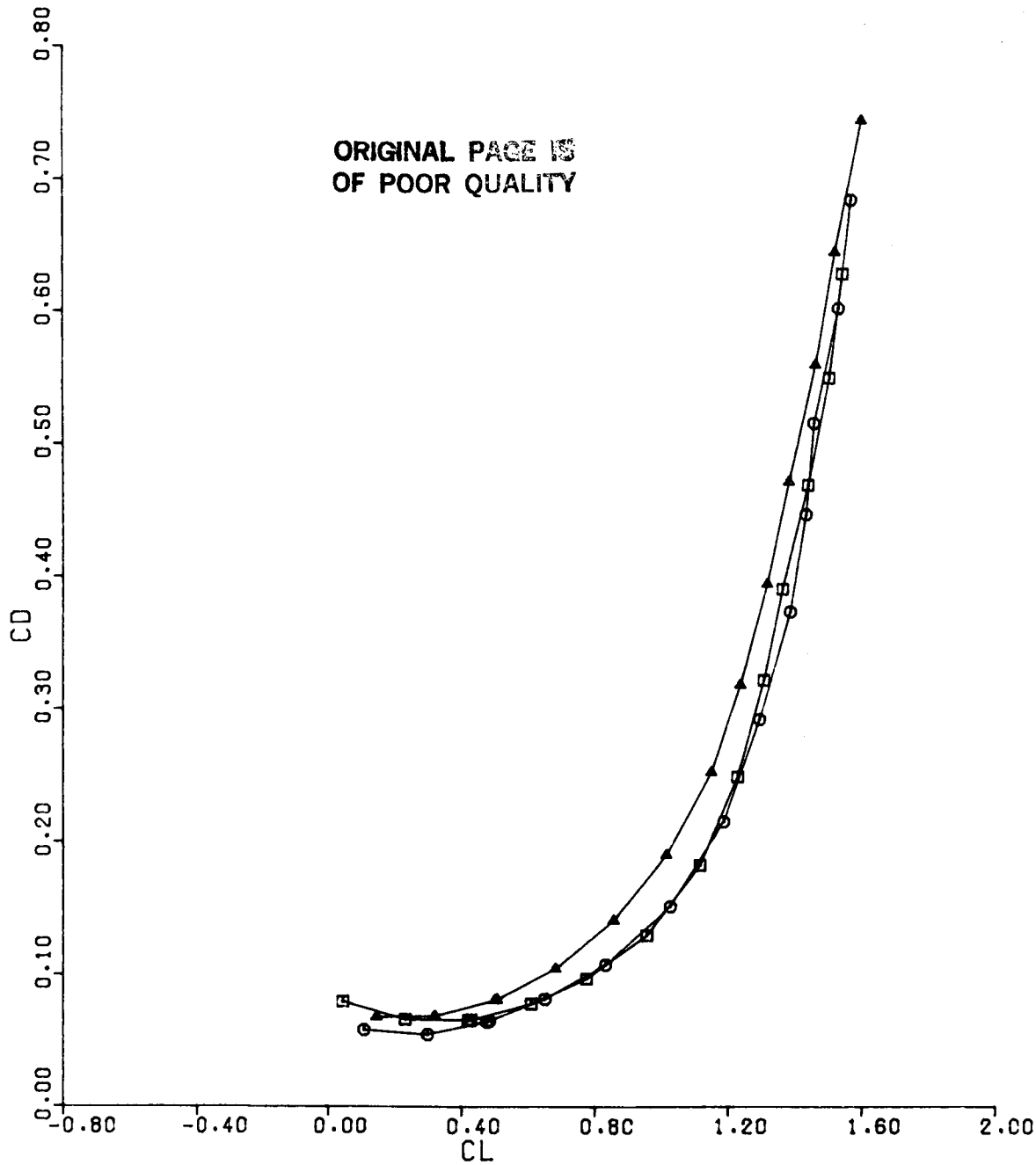

Figure 47(b). CD vs CL, DS = 0,
Configuration 3, BETA = 0, MACH = 0.6

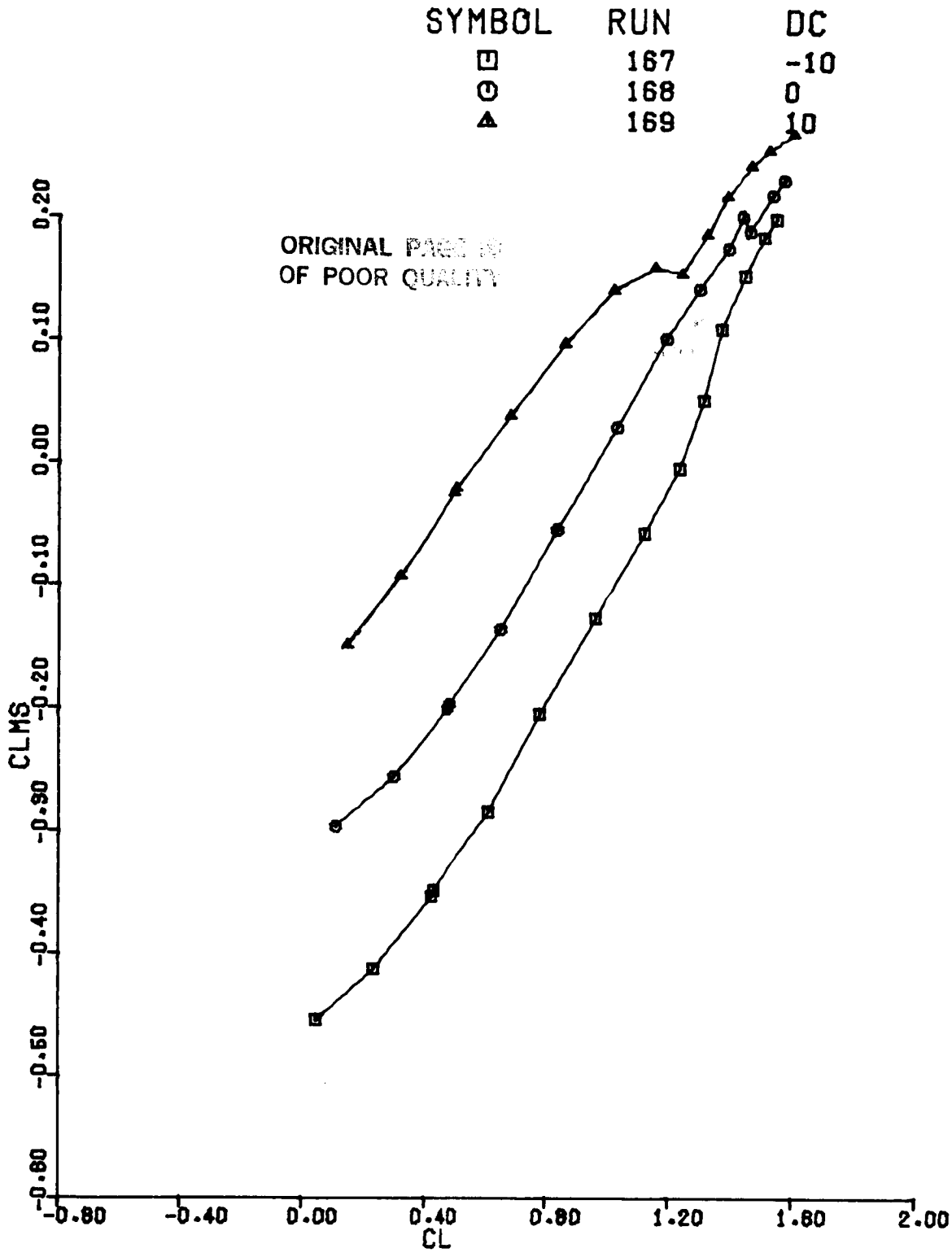

Figure 47(c). CLMS vs CL, DS = 0,
Configuration 3, BETA = 0, MACH = 0.6

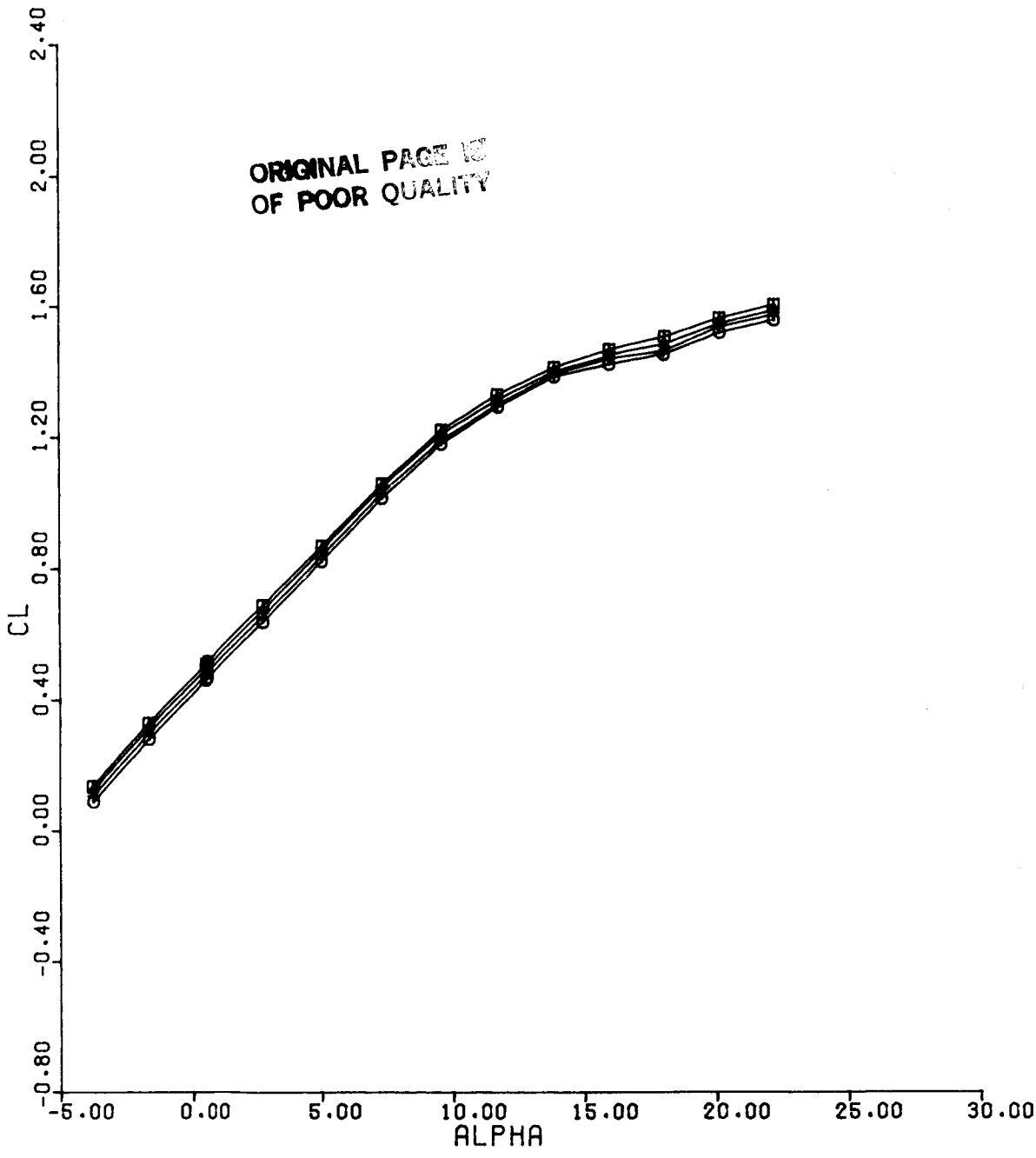

Figure 48(a). CL vs ALPHA, DC = 0, Configuration 3, BETA = 0, MACH = 0.6

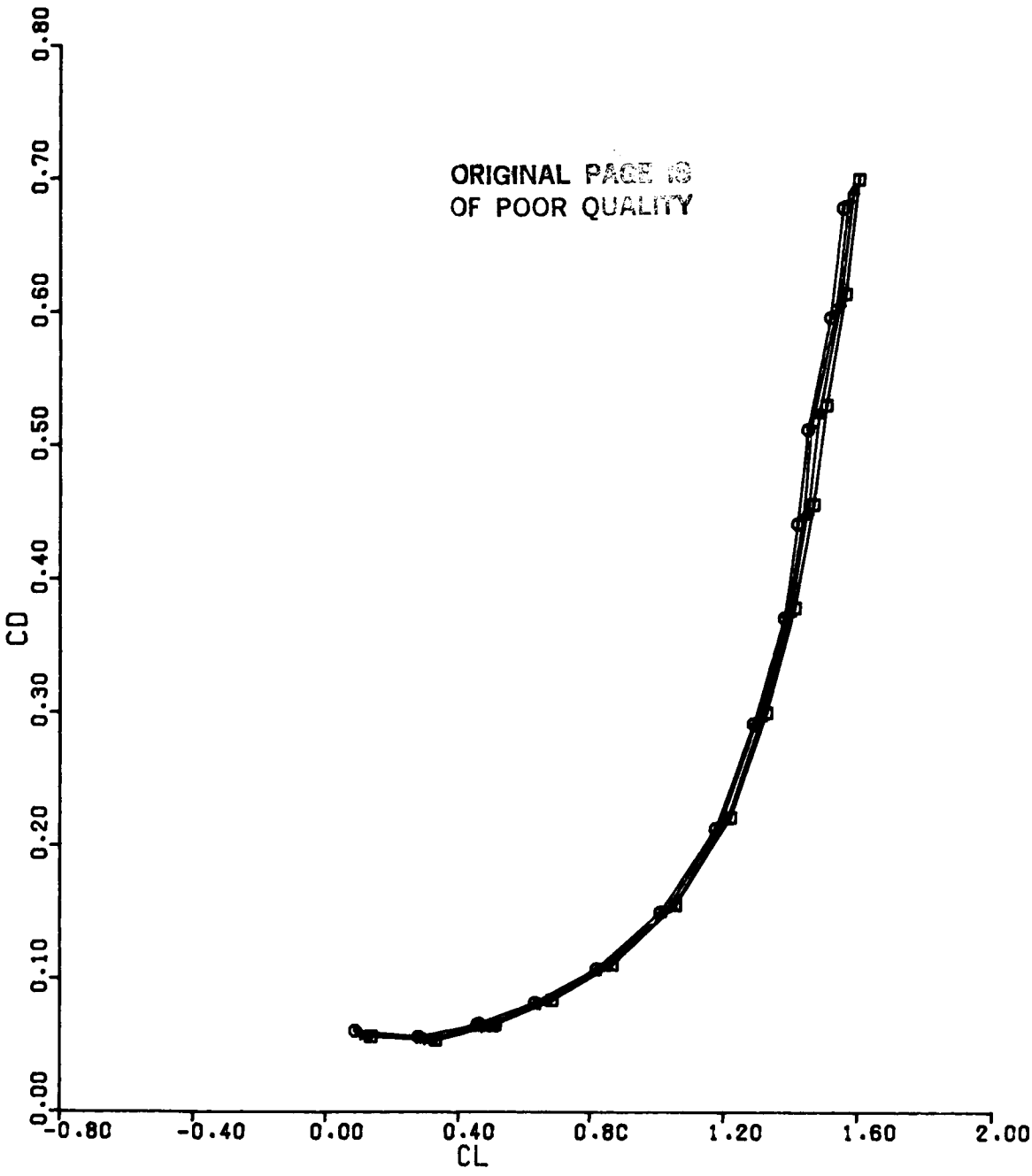

Figure 48(b). CD vs CL, DC = 0,
Configuration 3, BETA = 0, MACH = 0.6

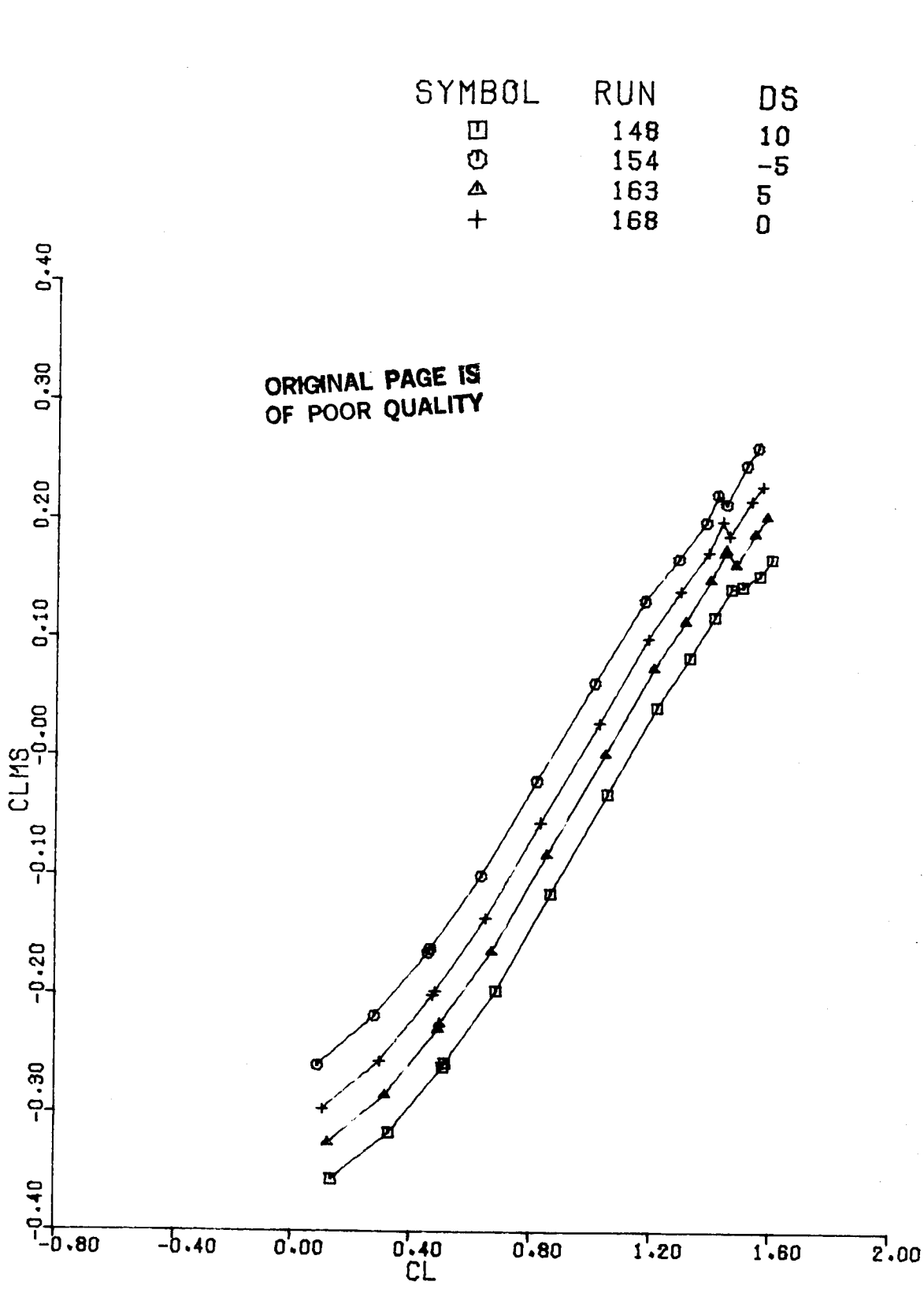

Figure 48(c). CLMS vs CL, DC = 0, Configuration 3, BETA = 0, MACH = 0.6

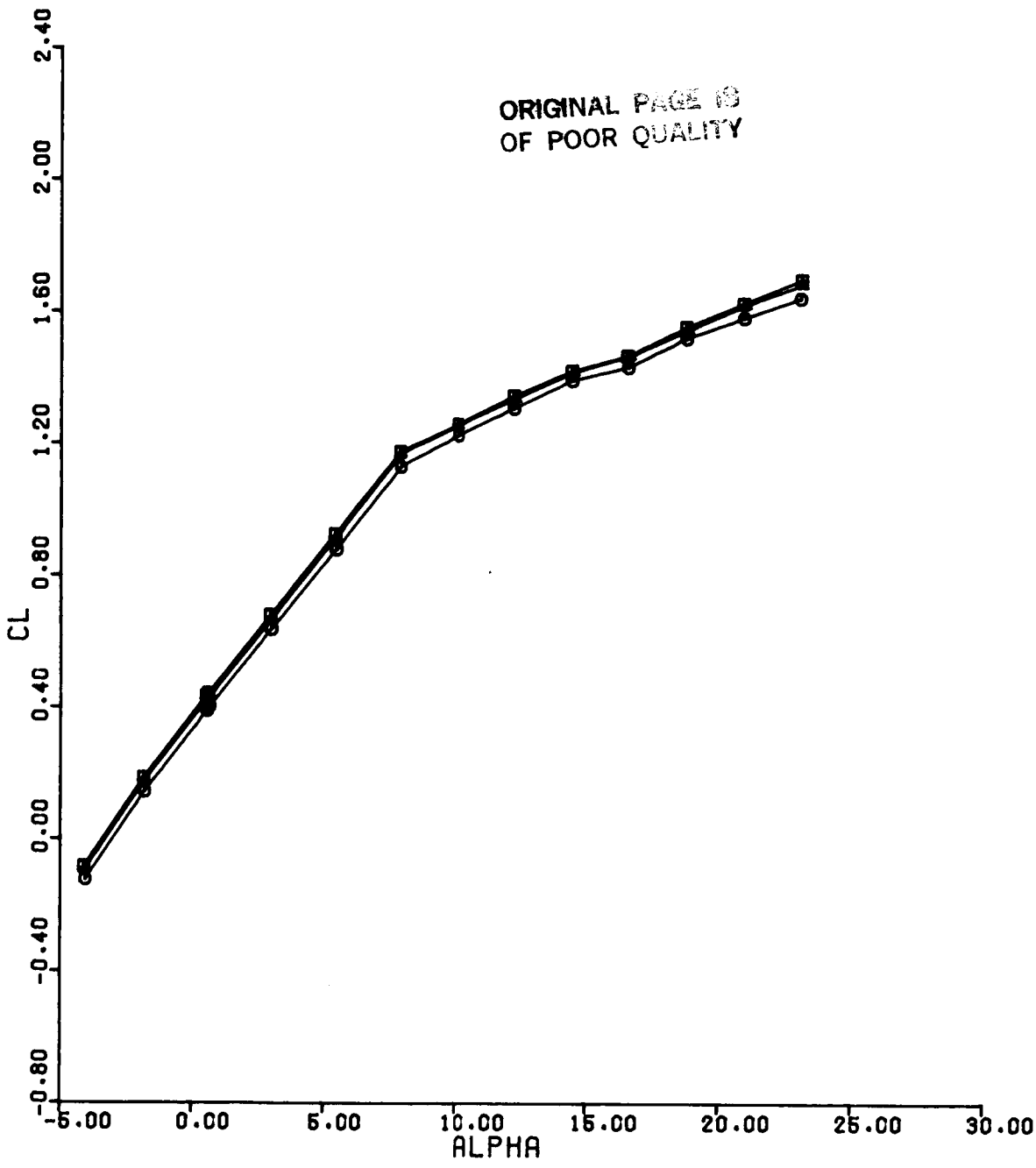

Figure 49(a). CL vs ALPHA, DC = 0,
Configuration 3, BETA = 0, MACH = 0.9

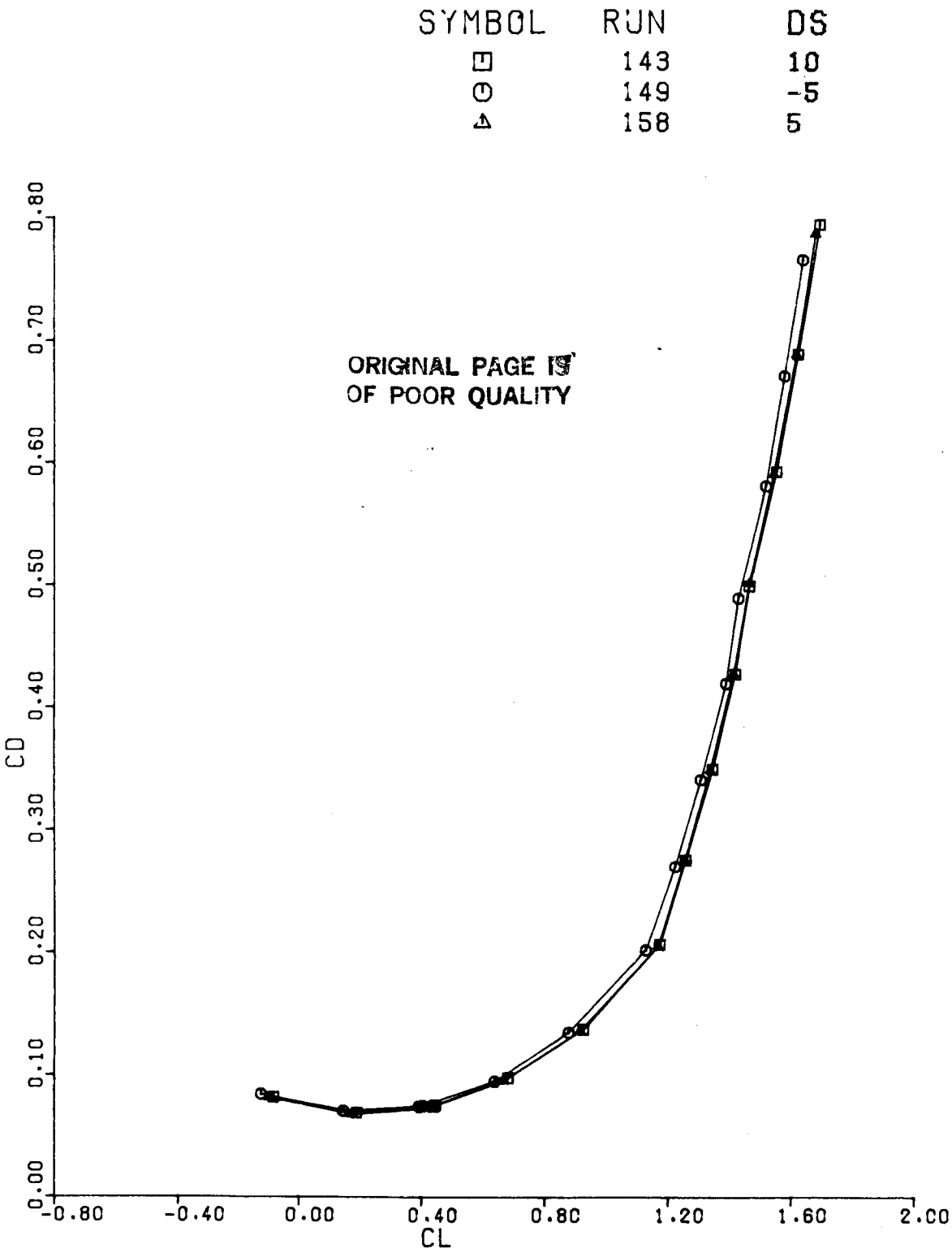

Figure 49(b). CD vs CL
Configuration 3, BETA = 0, MACH = 0.9

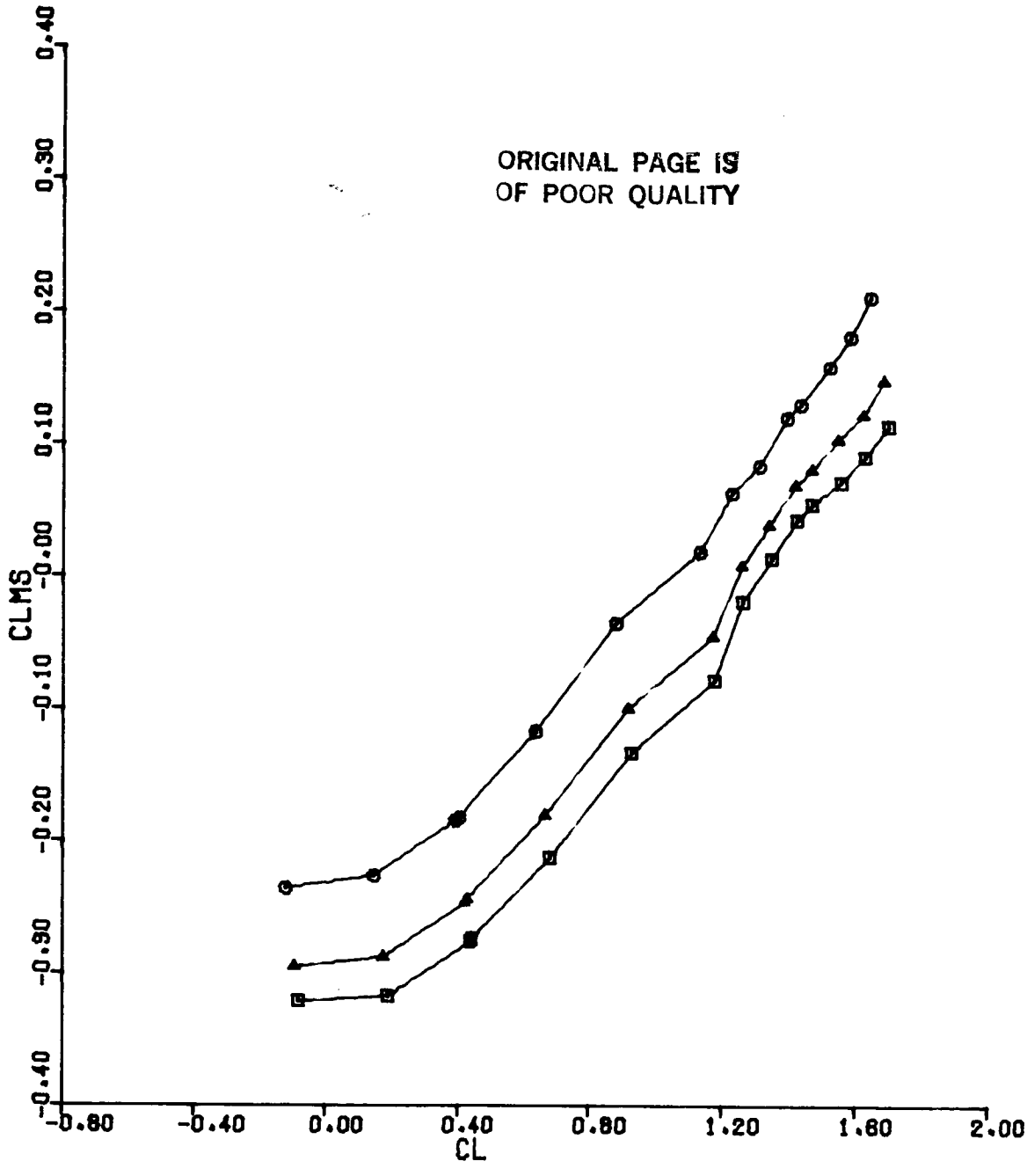

Figure 49(c). CLMS vs CL, DC = 0, Configuration 3, BETA = 0, MACH = 0.9

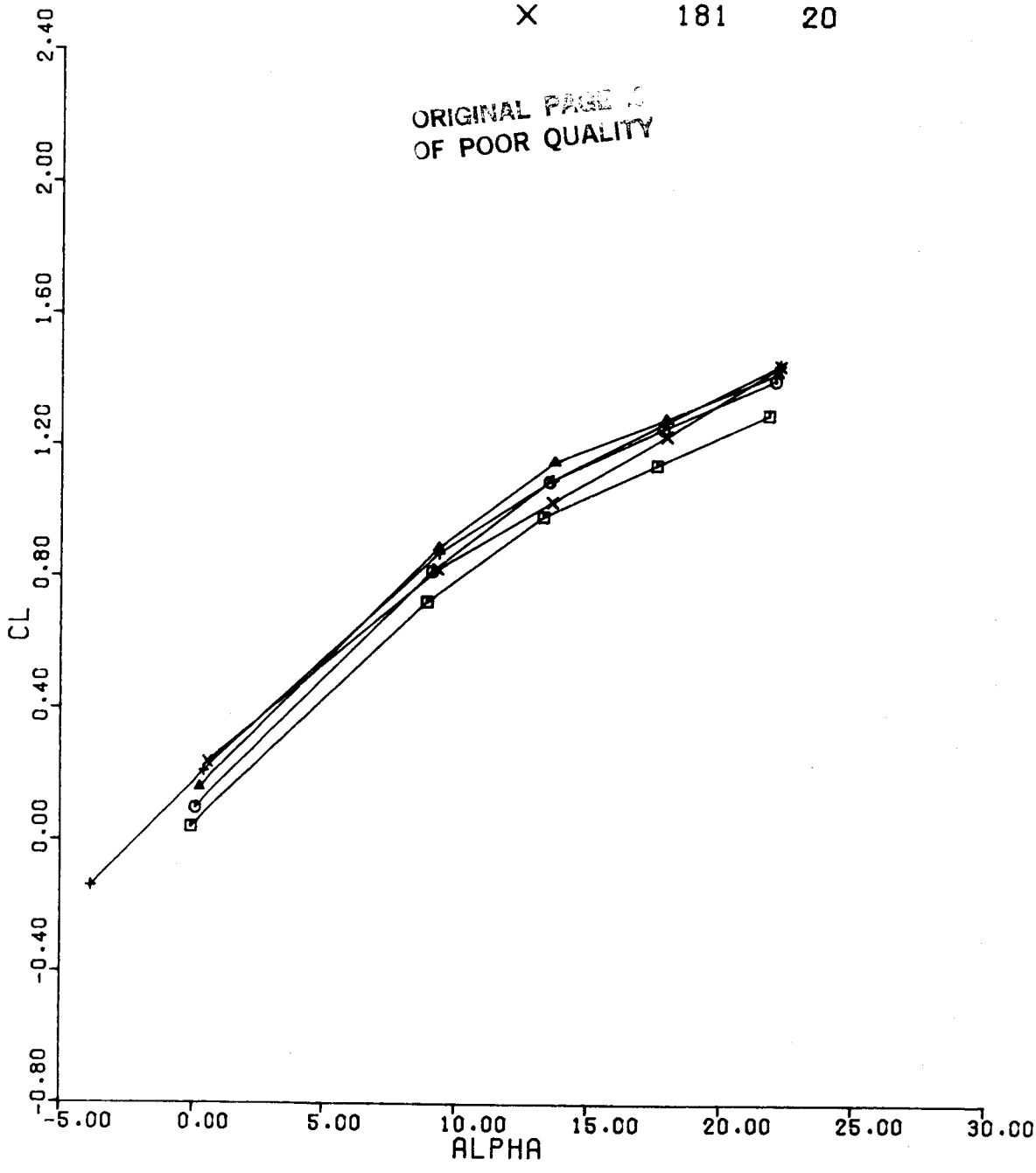

Figure 50(a). CL vs ALPHA
Configuration 4, BETA = 0, MACH = 0.6

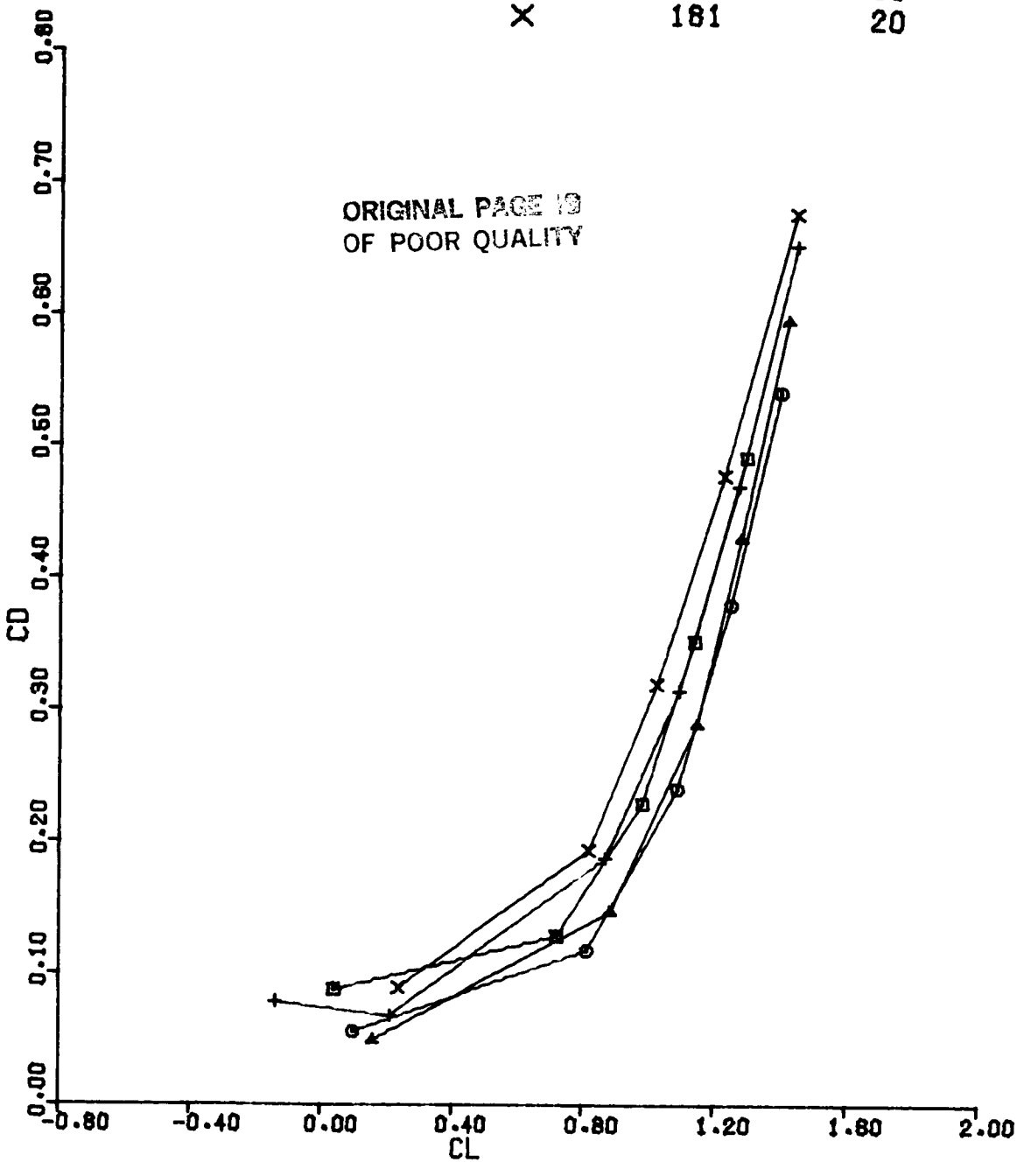

Figure 50(b). CD vs CL
Configuration 4, BETA = 0, MACH = 0.6

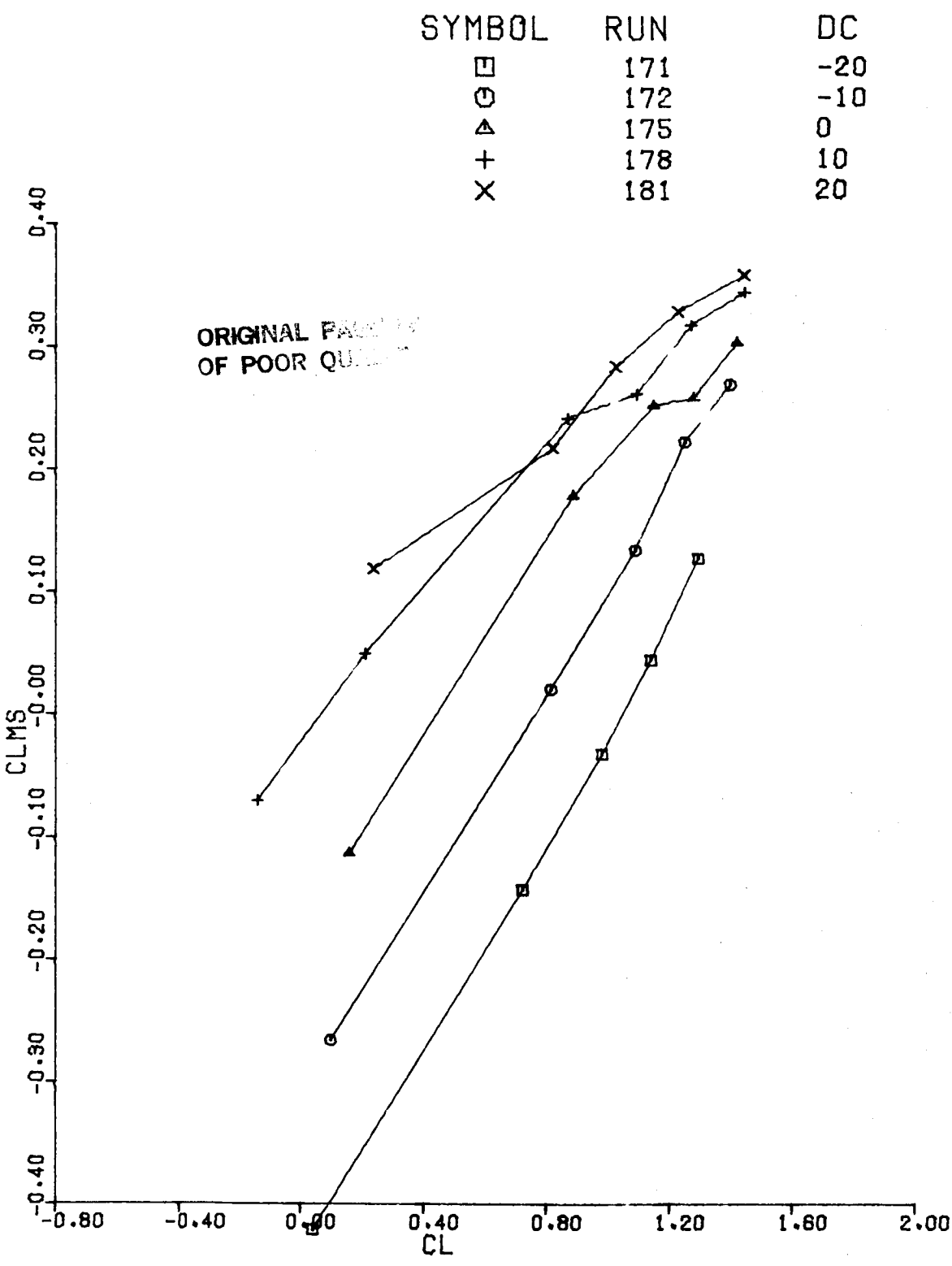

Figure 50(c). CLMS vs CL
Configuration 4, BETA = 0, MACH = 0.6

SYMBOL	RUN	DC
⊡	173	-10
⊙	176	0
▲	179	10

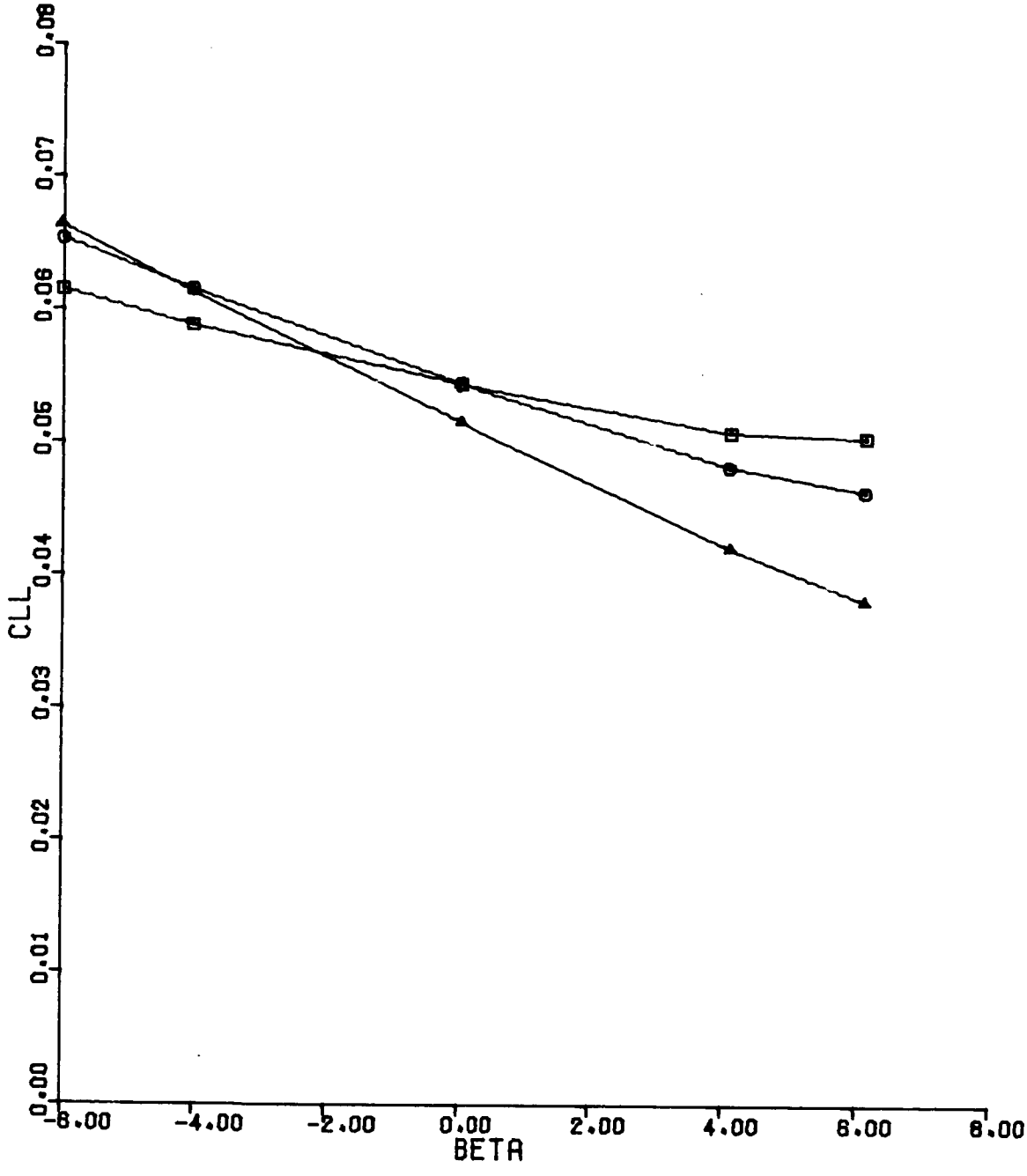

Figure 51(a). CLL vs BETA
Configuration 4, ALPHA = 10, MACH = 0.6

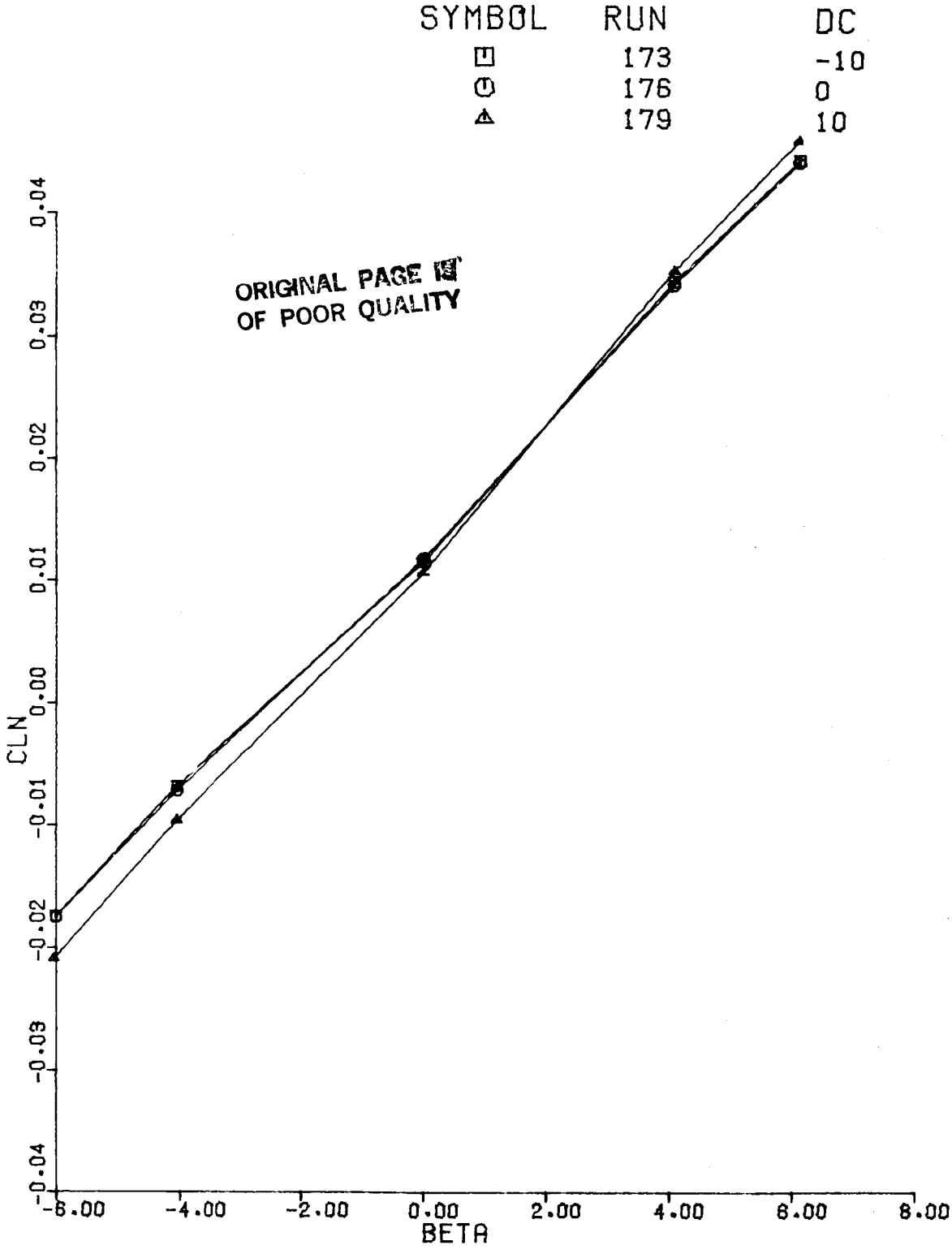

Figure 51(b). CLN vs BETA
Configuration 4, ALPHA = 10, MACH = 0.6

SYMBOL	RUN	DC
□	173	-10
○	176	0
△	179	10

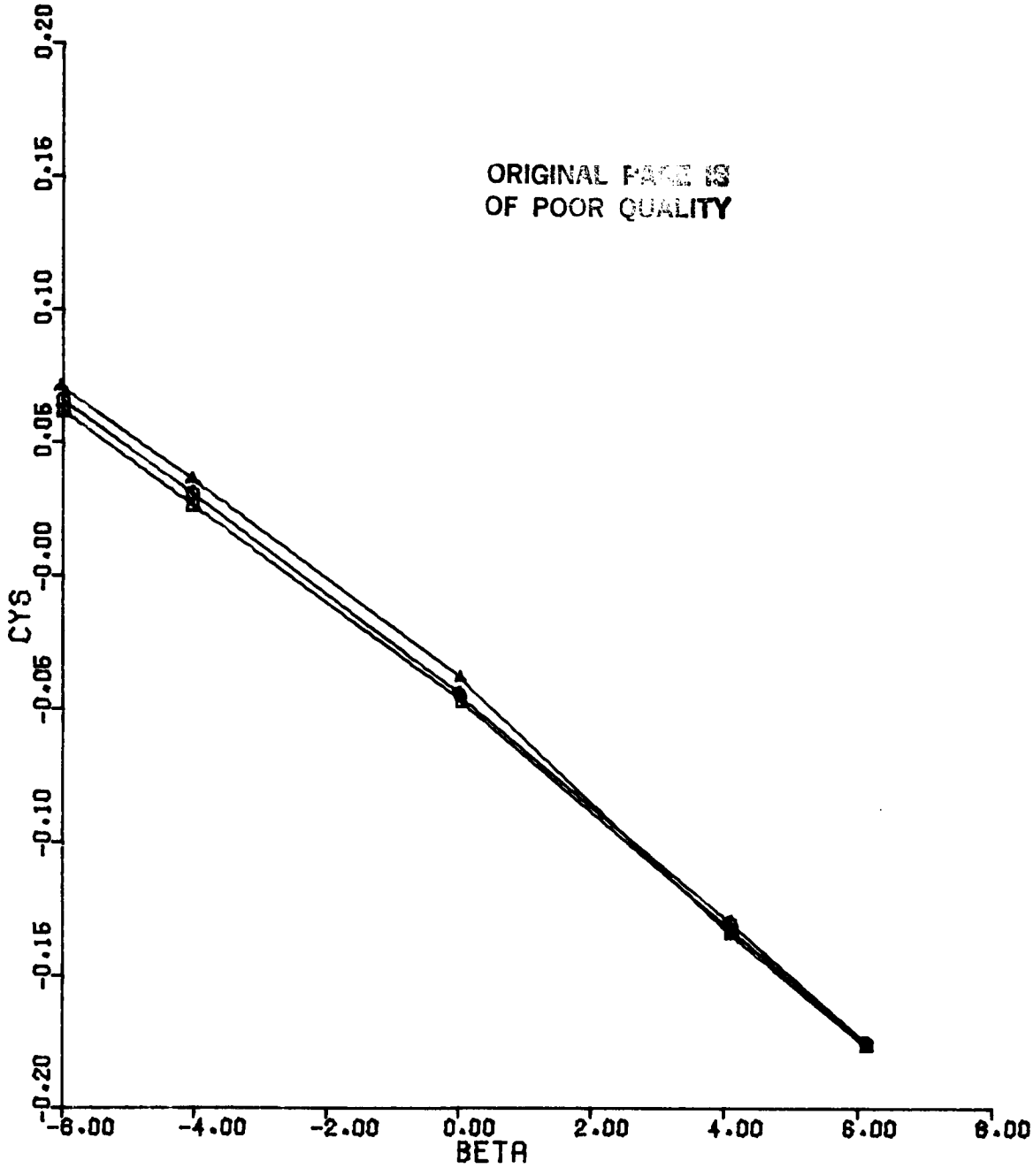

Figure 51(c). CYS vs BETA
Configuration 4, ALPHA = 10, MACH = 0.6

SYMBOL	RUN	DC
□	182	0
○	185	-10
△	186	10

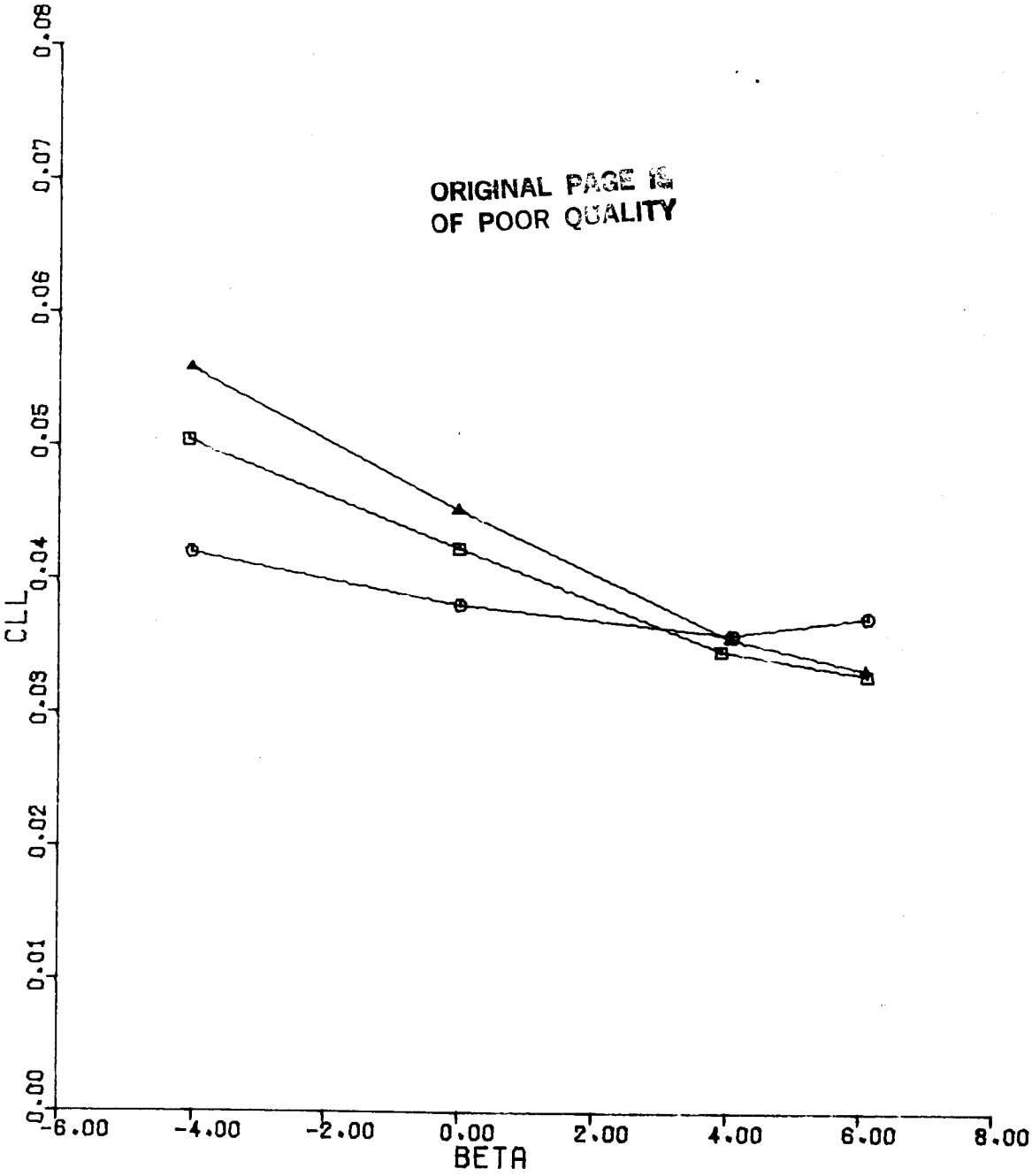

Figure 52(a). CLL vs BETA
Configuration 4, ALPHA = 11, MACH = 0.9

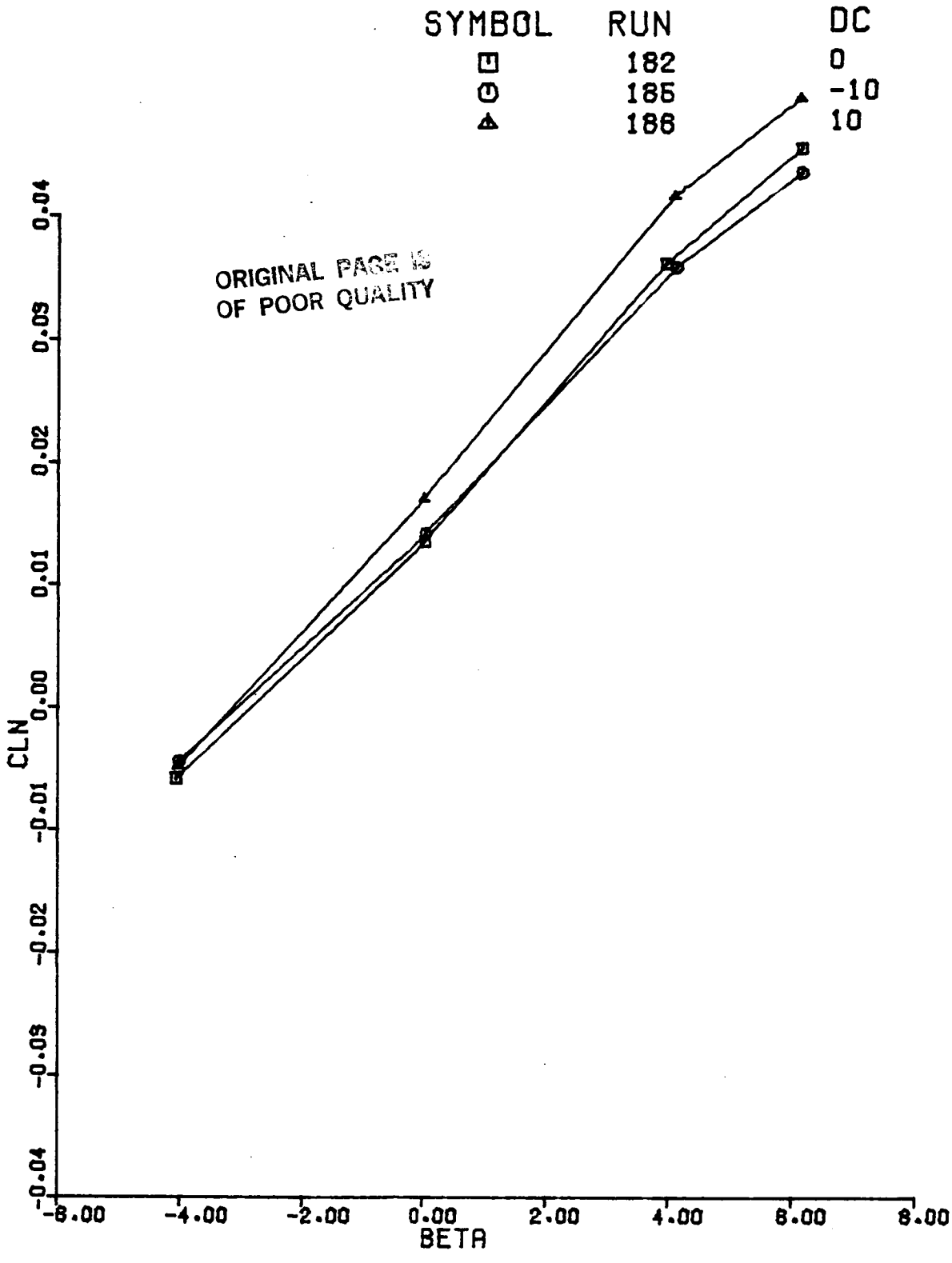

Figure 52(b). CLN vs BETA
Configuration 4, ALPHA = 11, MACH = 0.9

SYMBOL	RUN	DC
□	182	0
○	185	-10
△	186	10

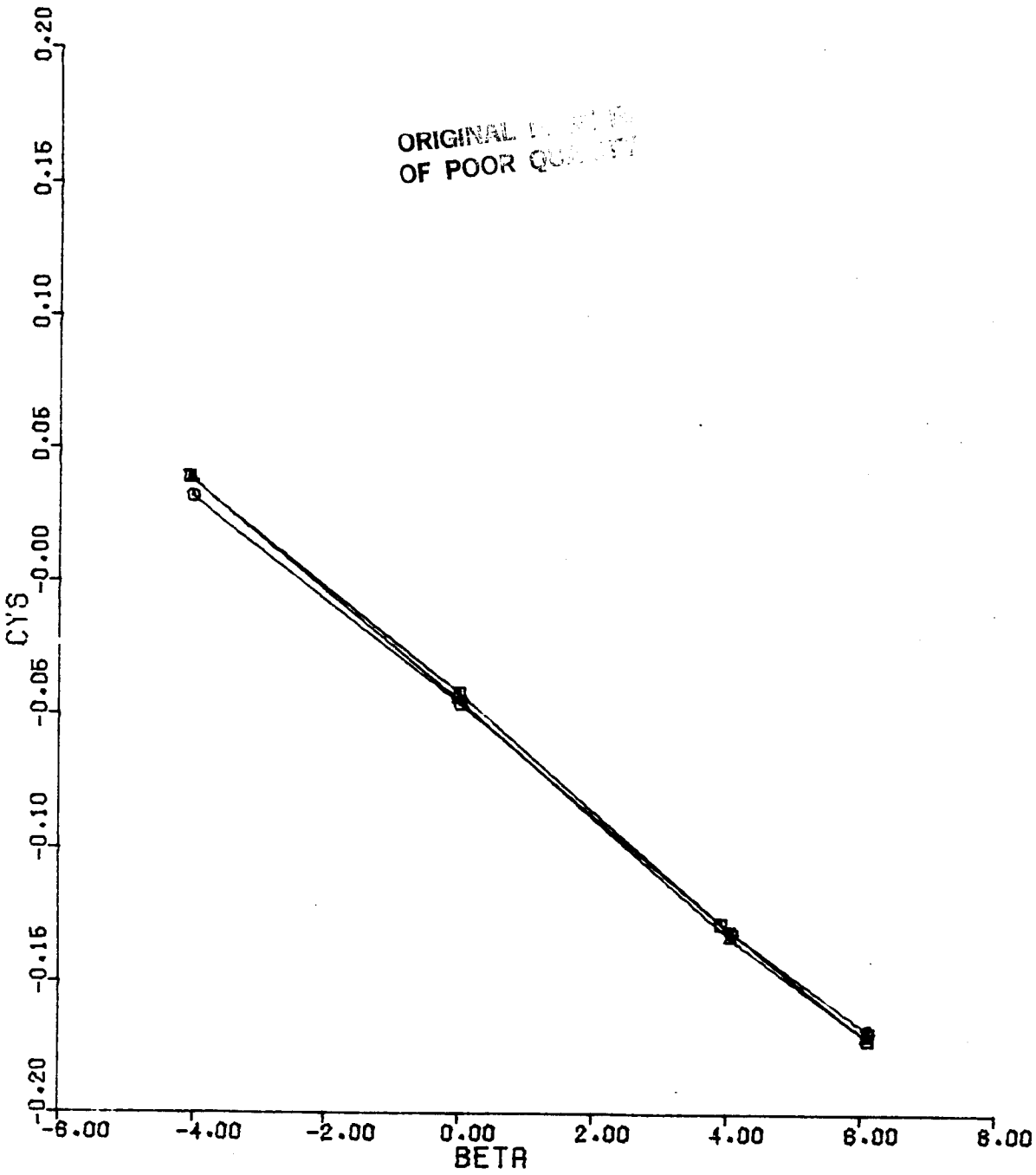

Figure 52(c). CYS vs BETA
Configuration 4, ALPHA = 11, MACH = 0.9

SYMBOL	RUN	DC
□	174	-10
○	177	0
△	180	10

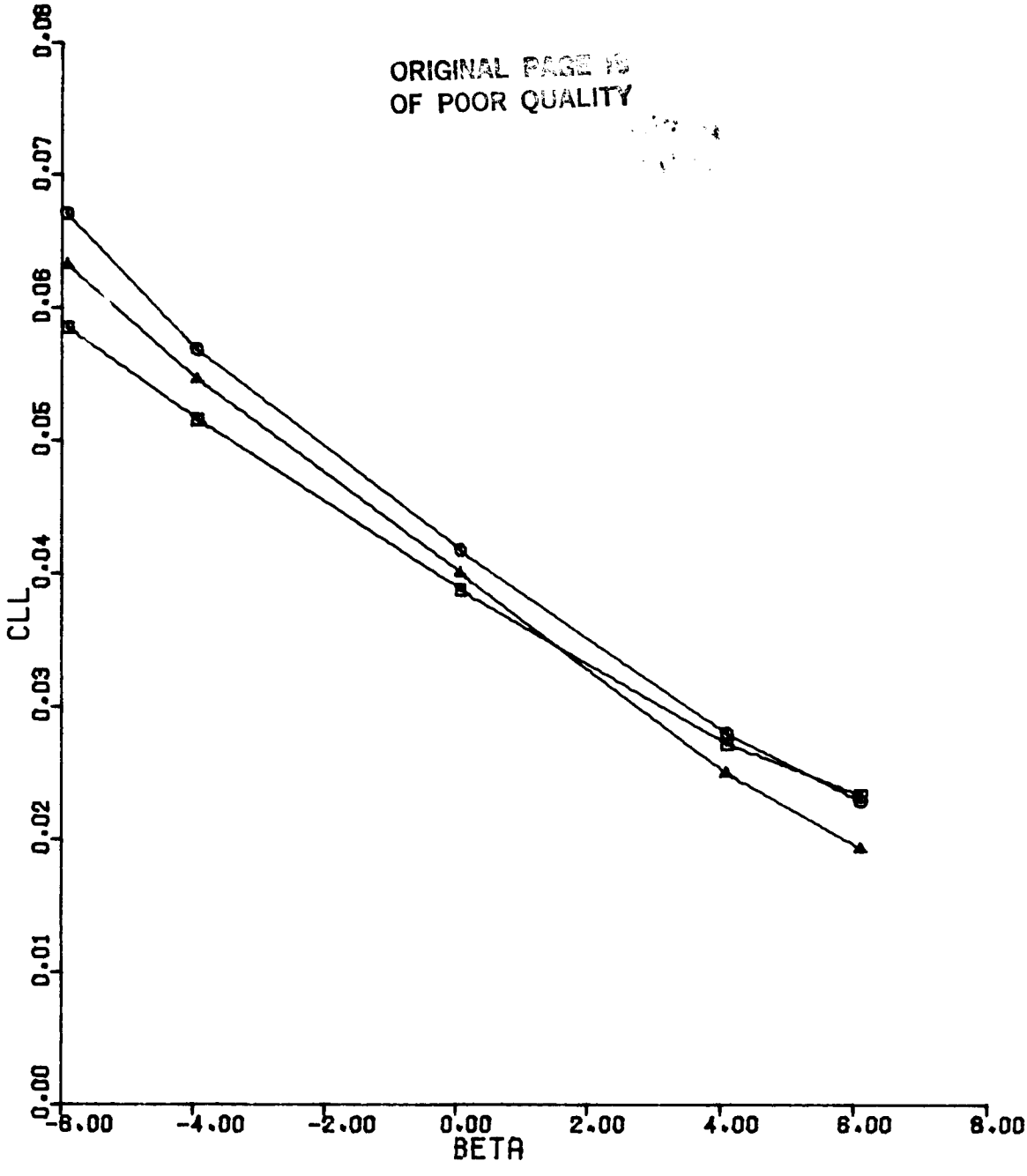

Figure 53(a). CLL vs BETA
Configuration 4, ALPHA = 15, MACH = 0.6

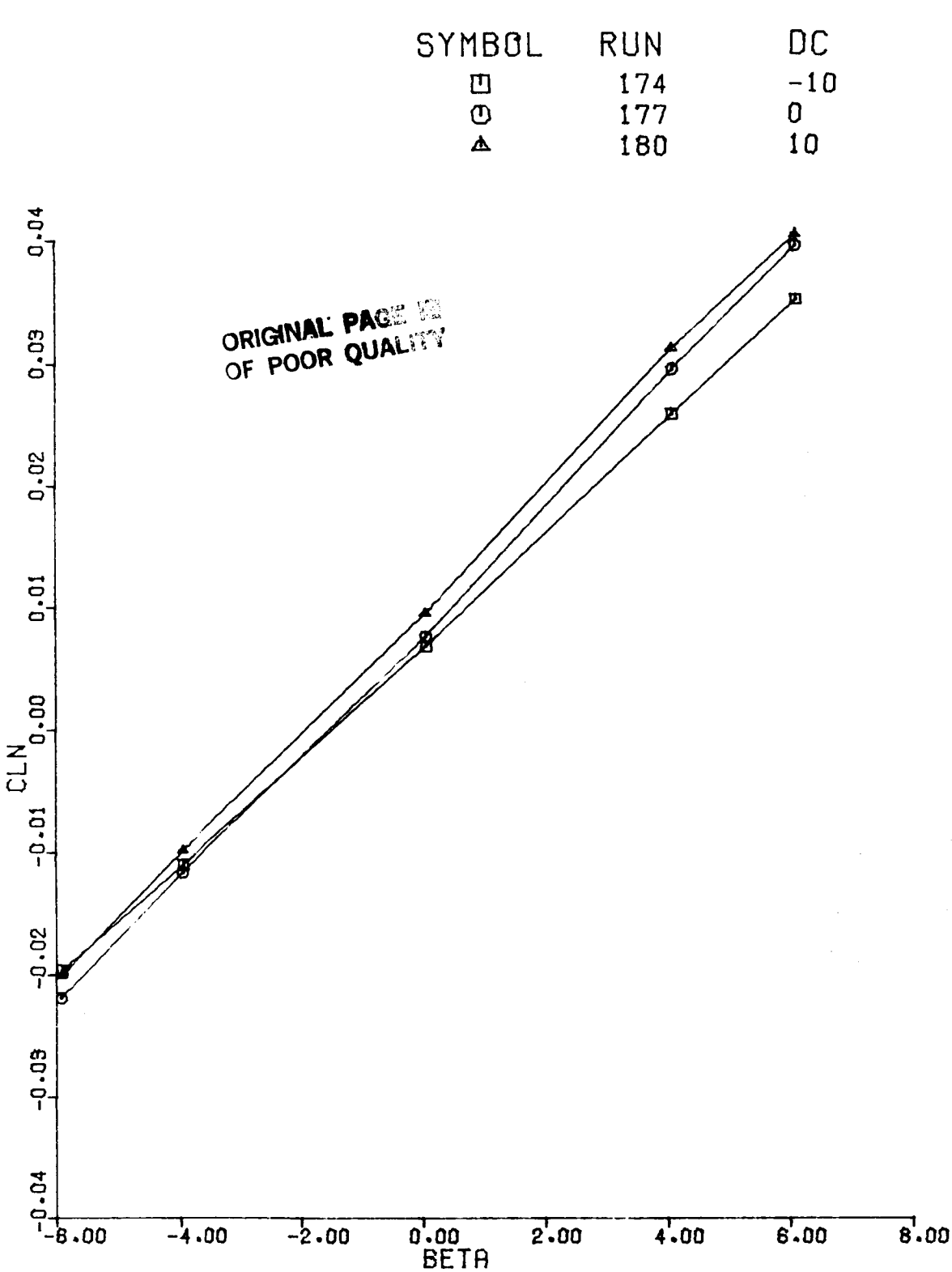

Figure 53(b). CLN vs BETA
Configuration 4, ALPHA = 15, MACH = 0.6

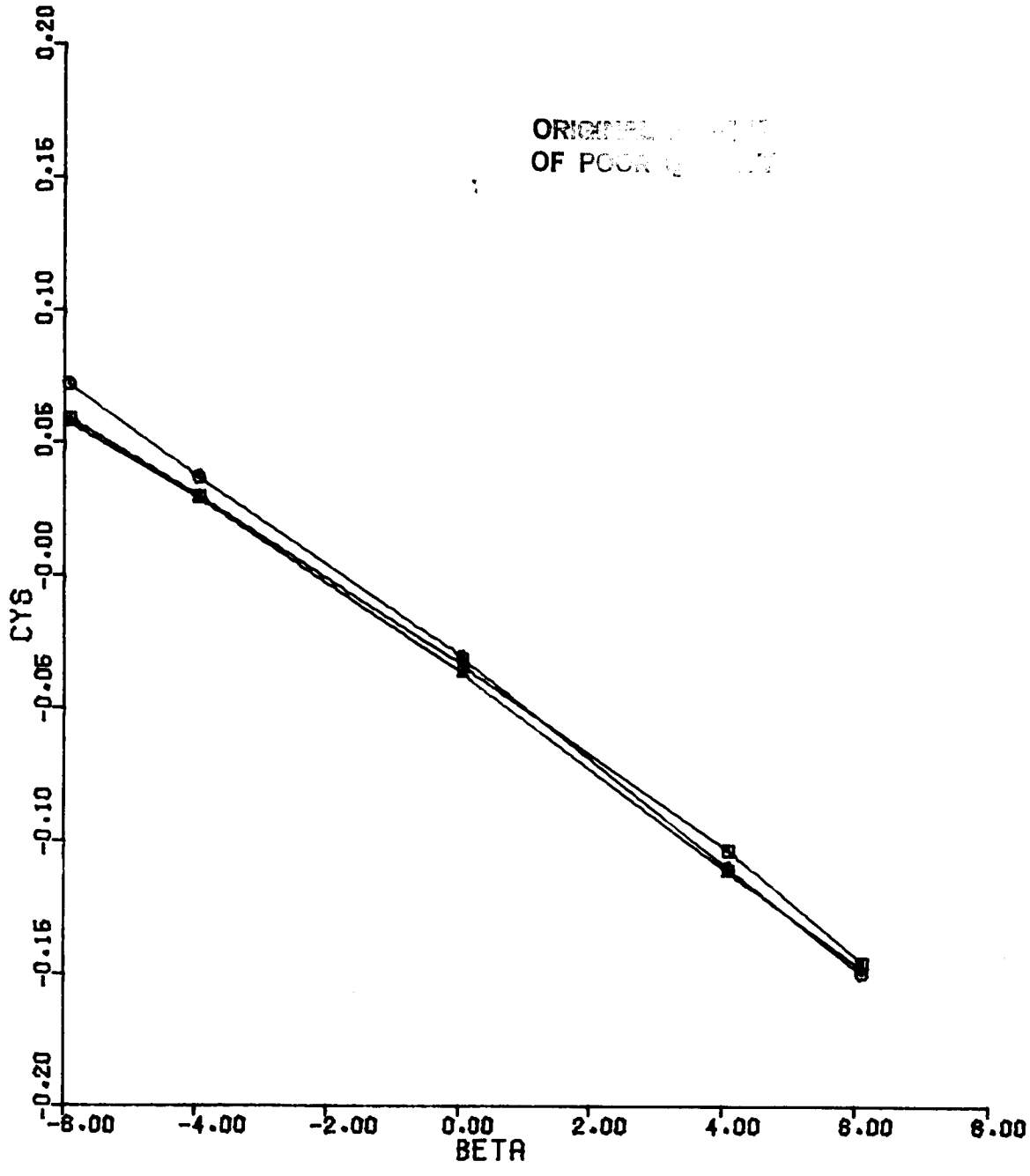

Figure 53(c). CYS vs BETA
Configuration 4, ALPHA = 15, MACH = 0.6

SYMBOL	RUN	DC
□	183	0
○	184	-10
△	187	10

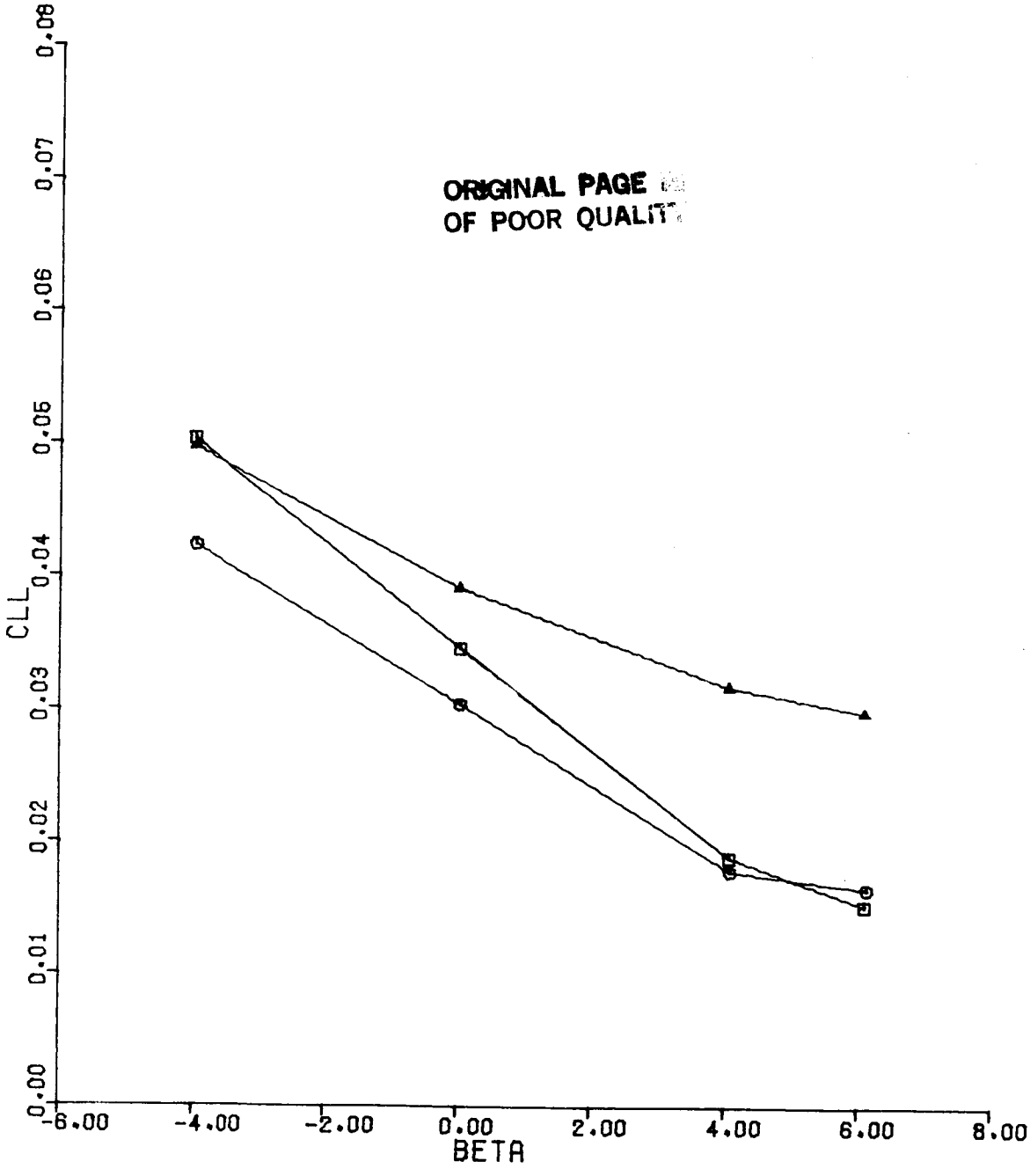

Figure 54(a). CLL vs BETA
Configuration 4, ALPHA = 16, MACH = 0.9

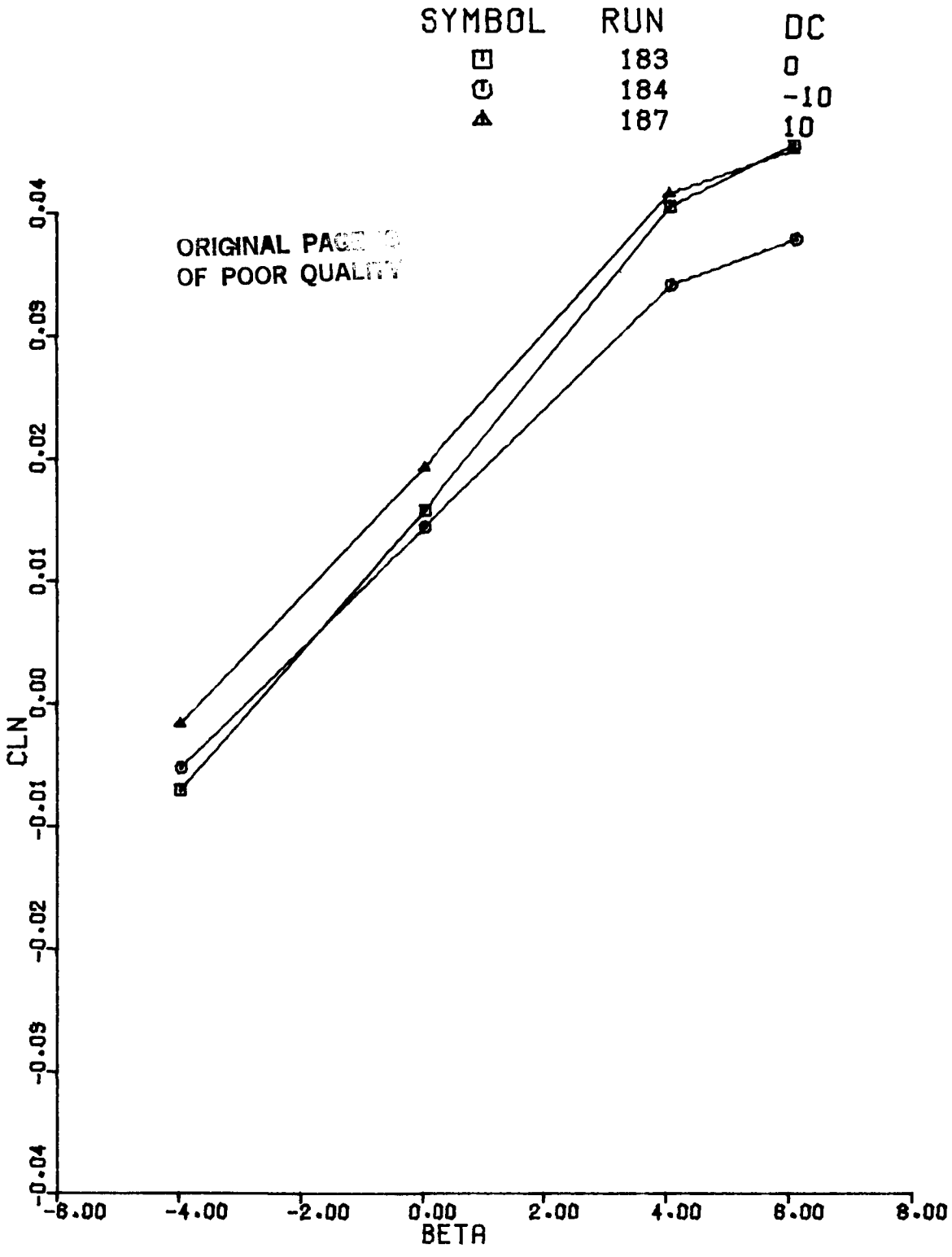

Figure 54(b). CLN vs BETA
Configuration 4, ALPHA = 16, MACH = 0.9

SYMBOL	RUN	DC
□	183	0
○	184	-10
△	187	10

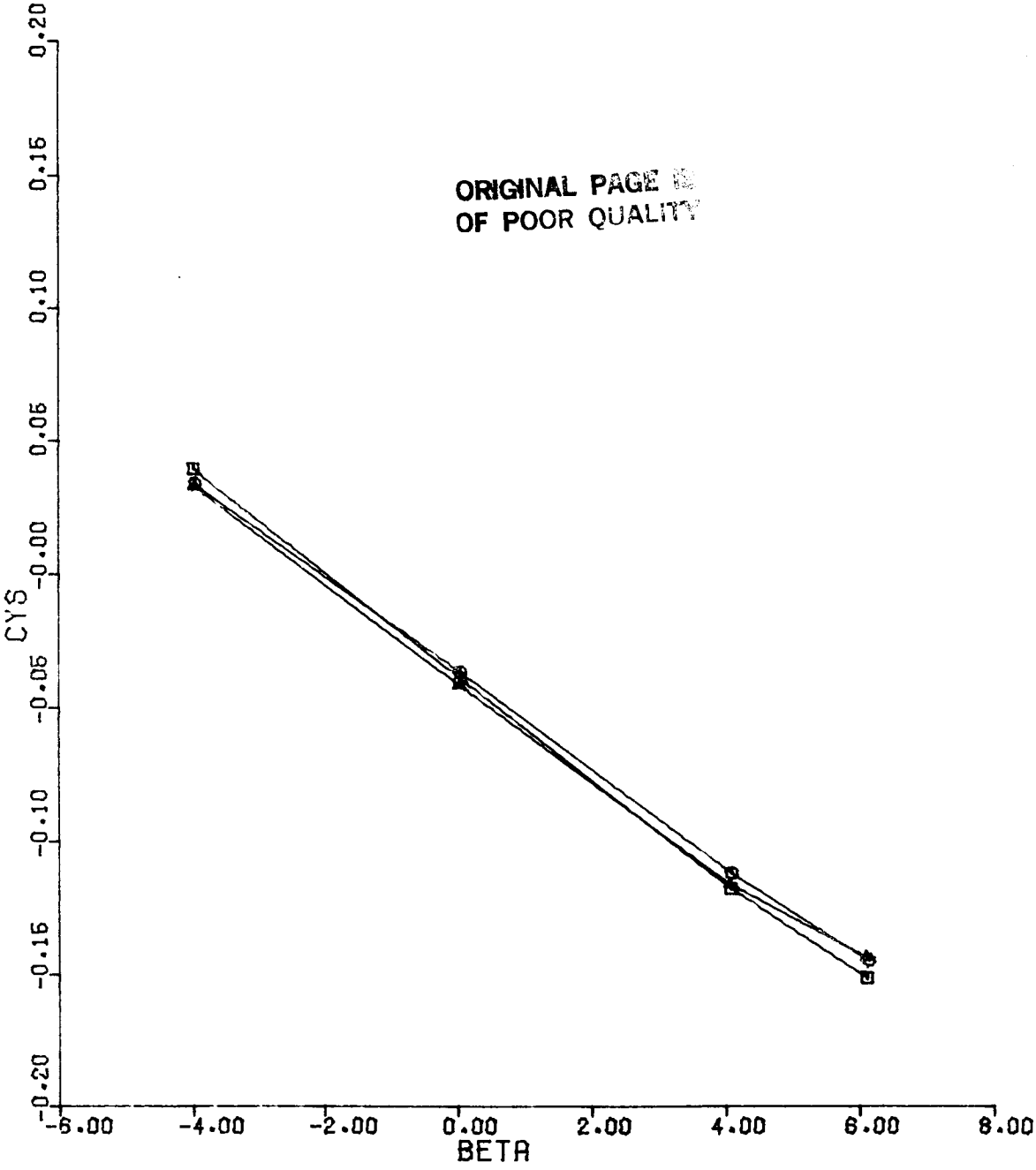

Figure 54(c). CYS vs BETA
Configuration 4, ALPHA = 16, MACH = 0.9

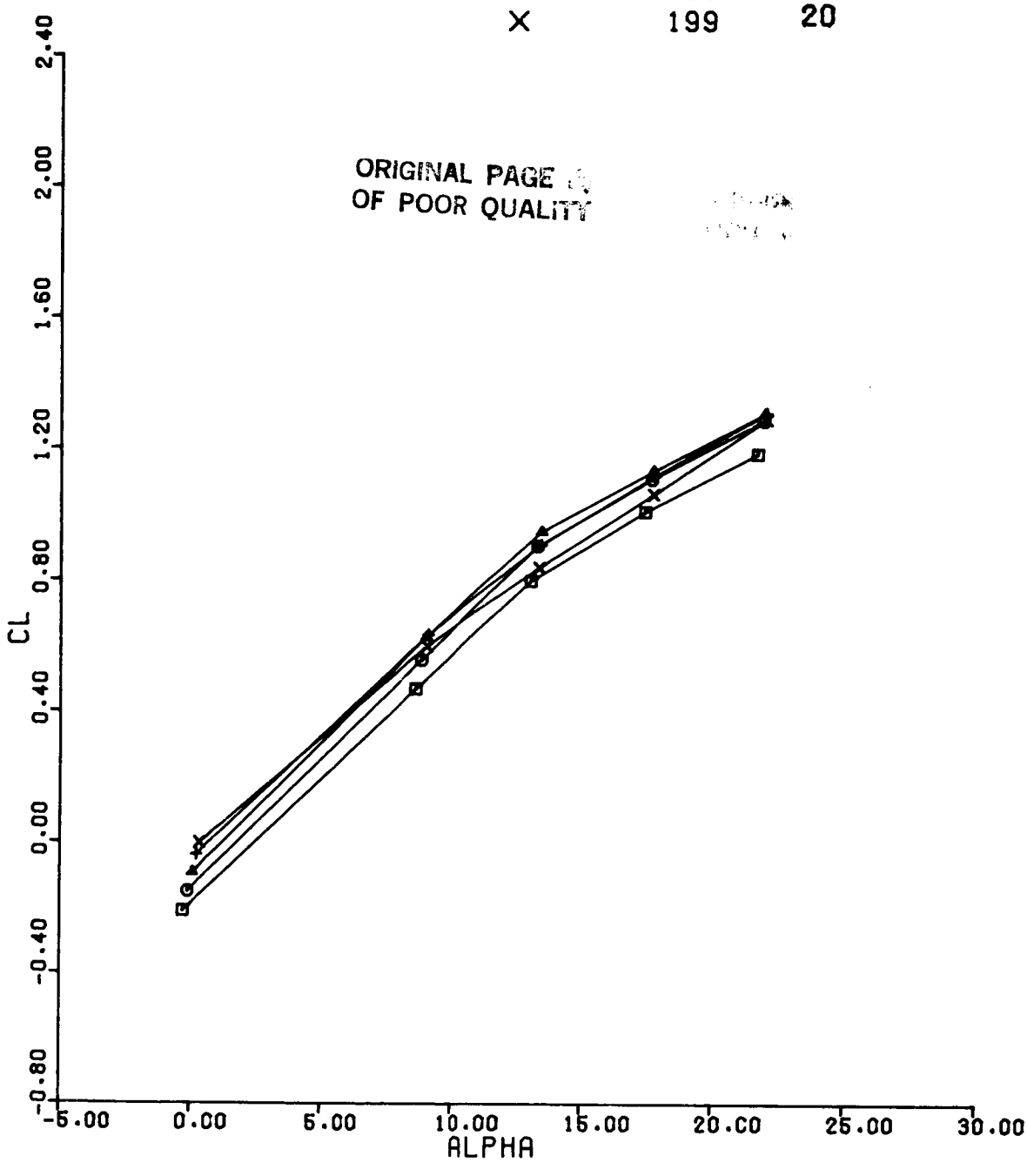

Figure 55(a). CL vs ALPHA
Configuration 5, BETA = 0, MACH = 0.6

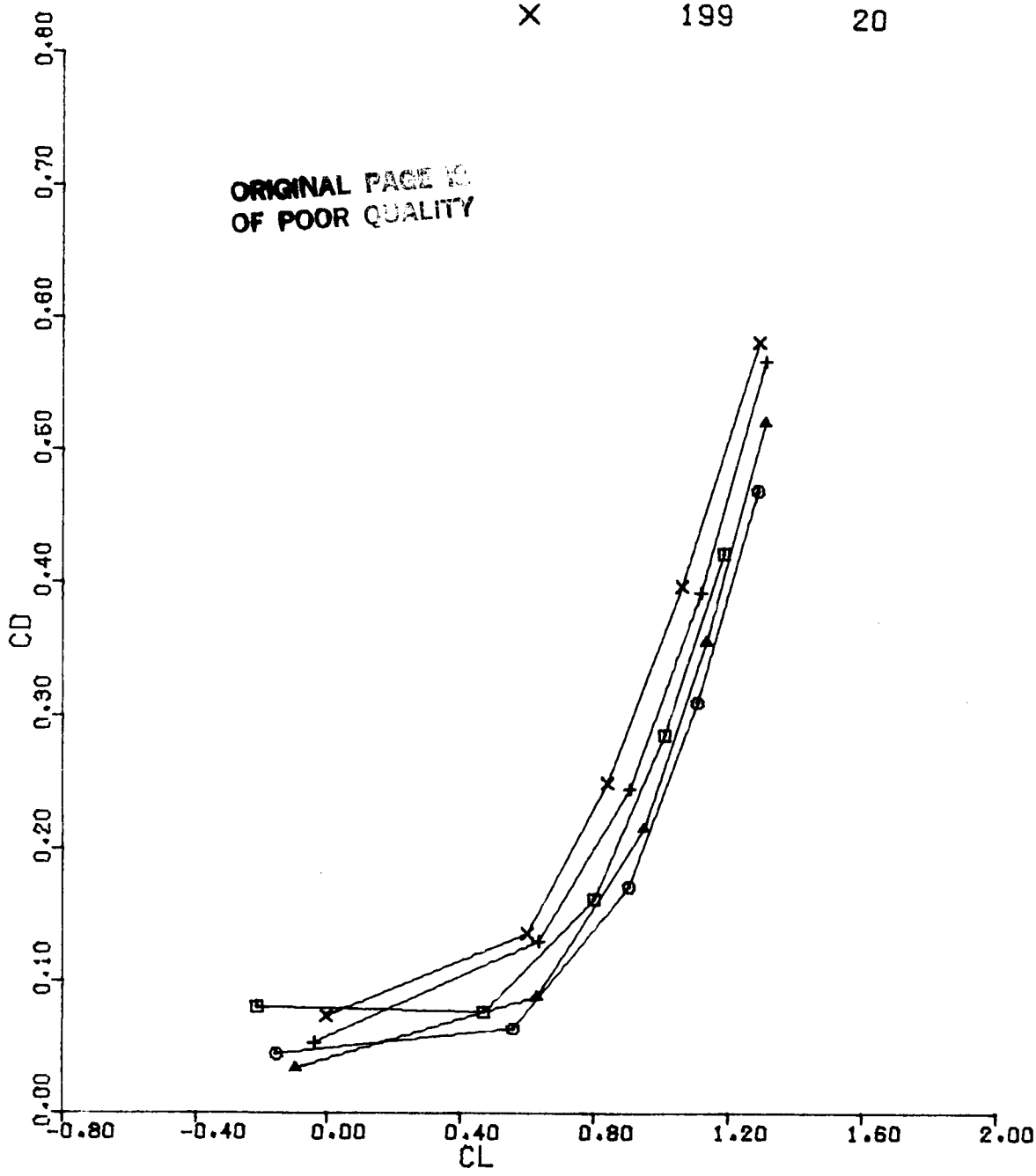

Figure 55(b). CD vs CL
Configuration 5, BETA = 0, MACH = 0.6

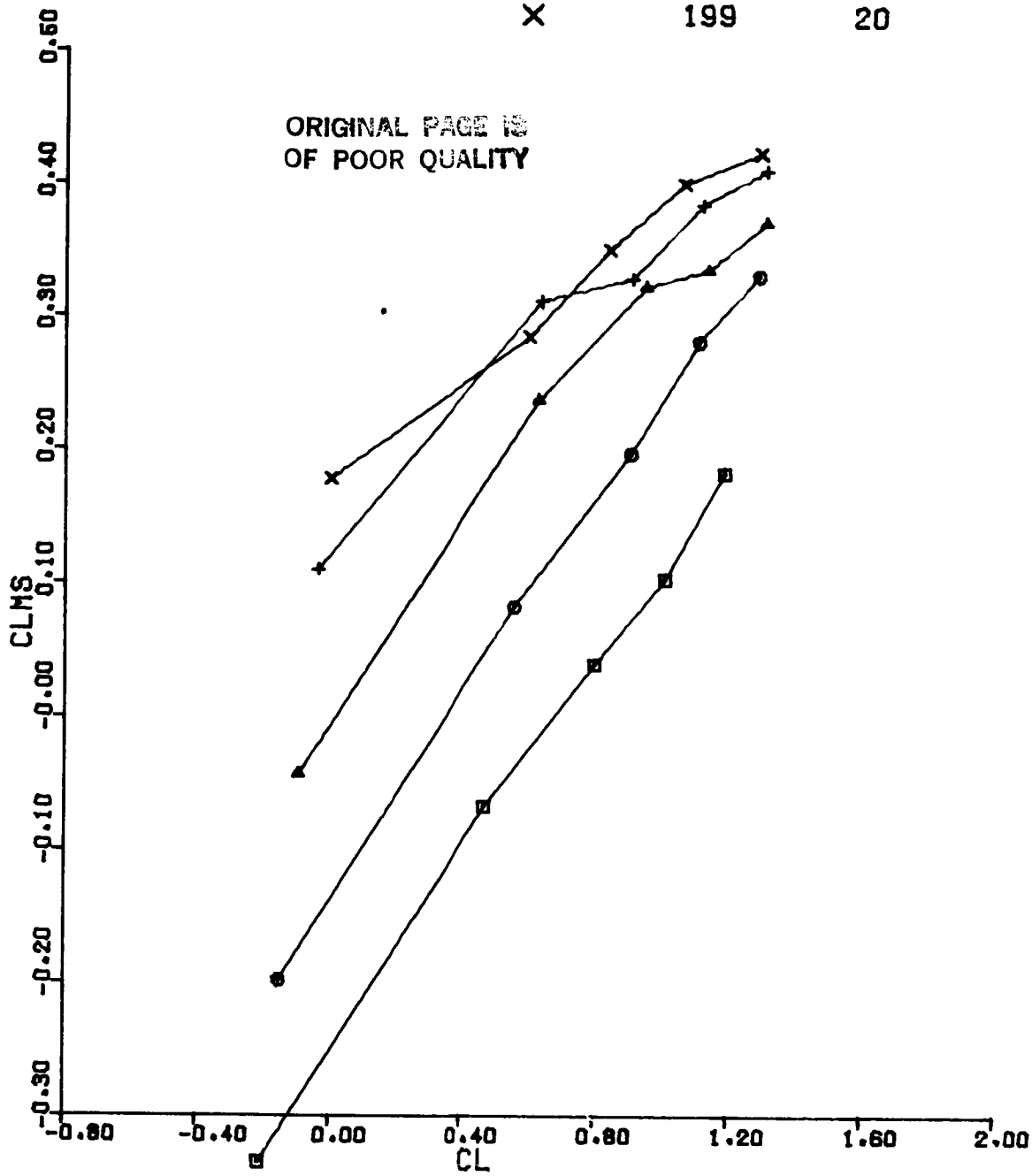

Figure 55(c). CLMS vs CL
Configuration 5, BETA = 0, MACH = 0.6

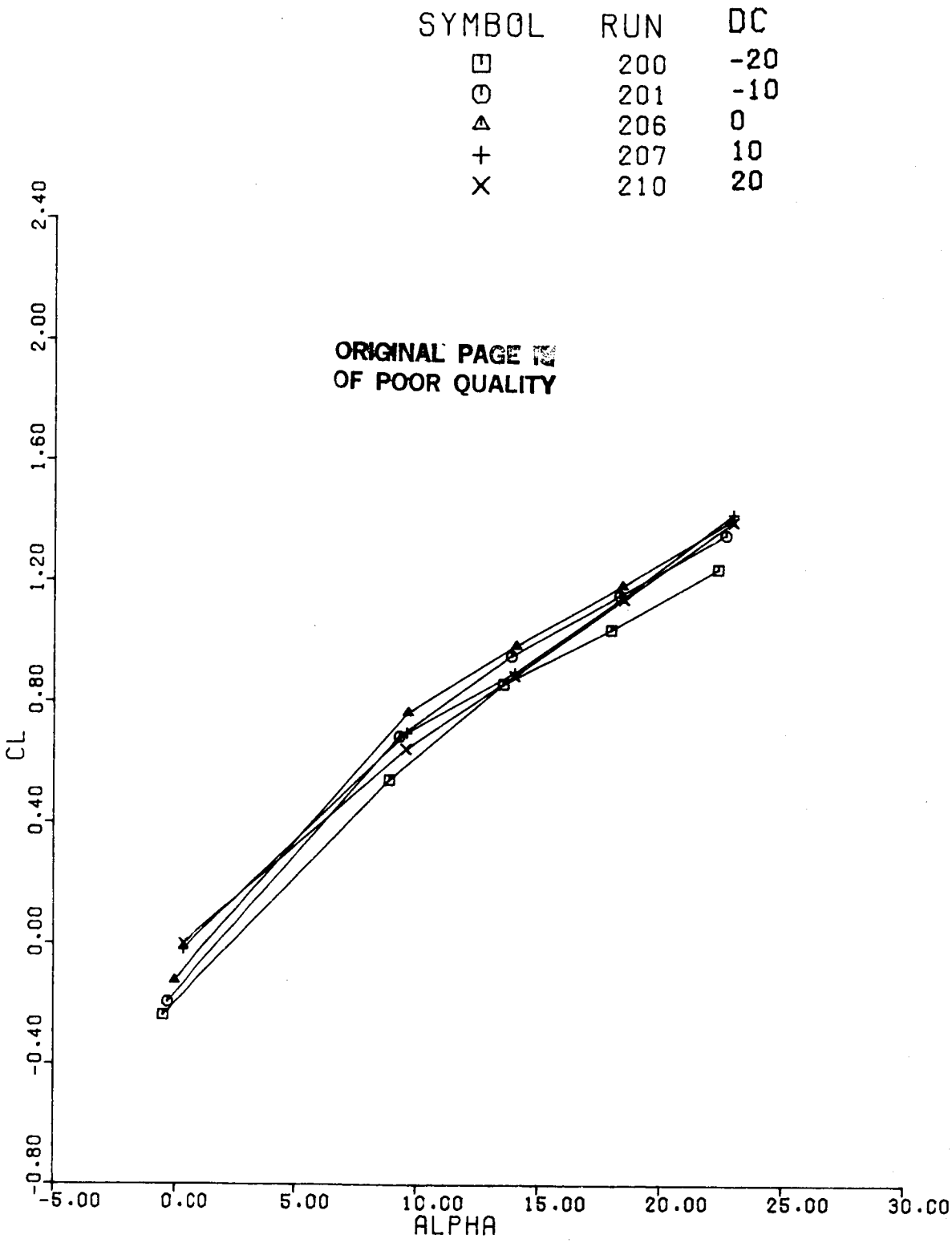

Figure 56(a). CL vs ALPHA
Configuration 5, BETA = 0, MACH = 0.9

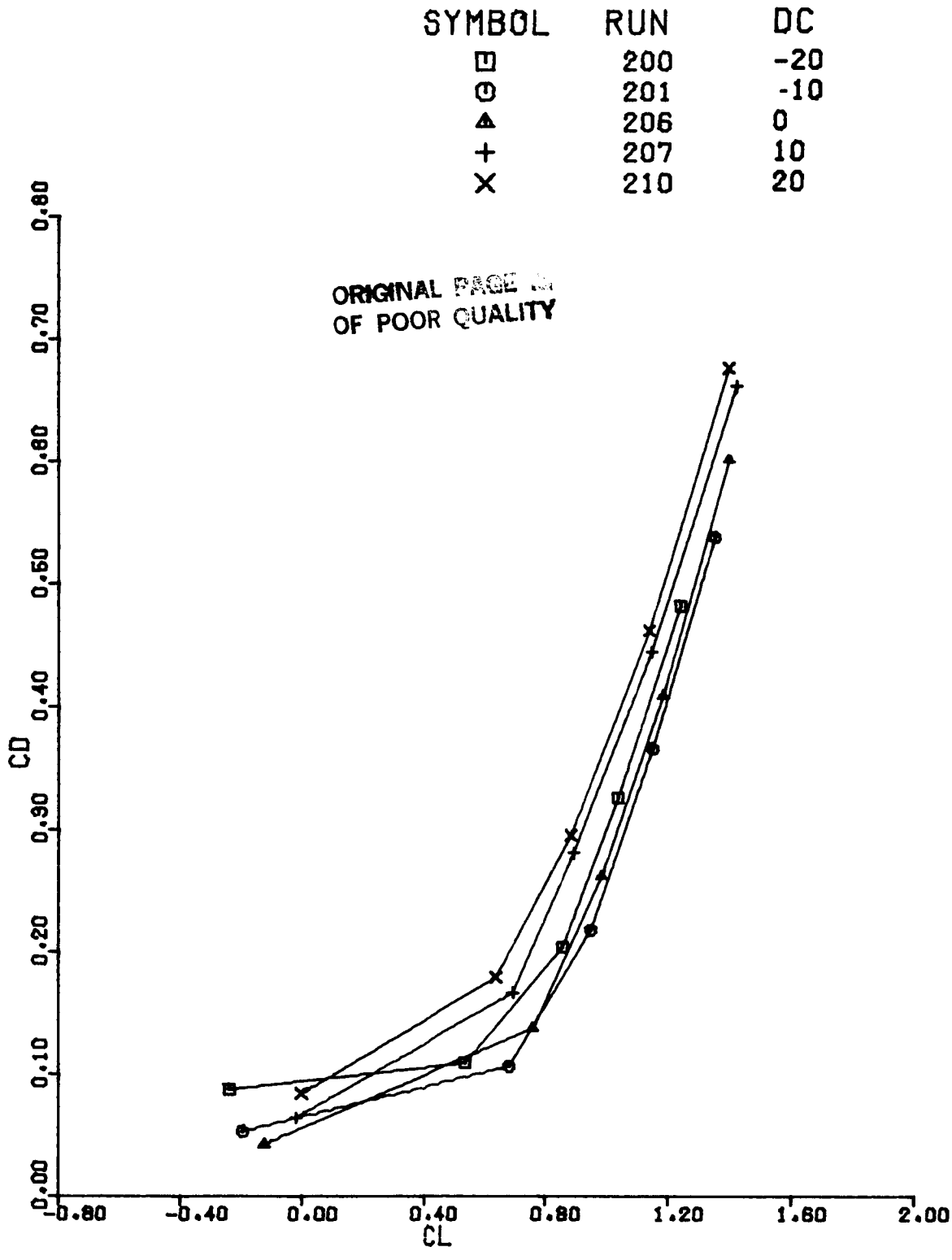

Figure 56(b). CD vs CL
Configuration 5, BETA = 0, MACH = 0.9

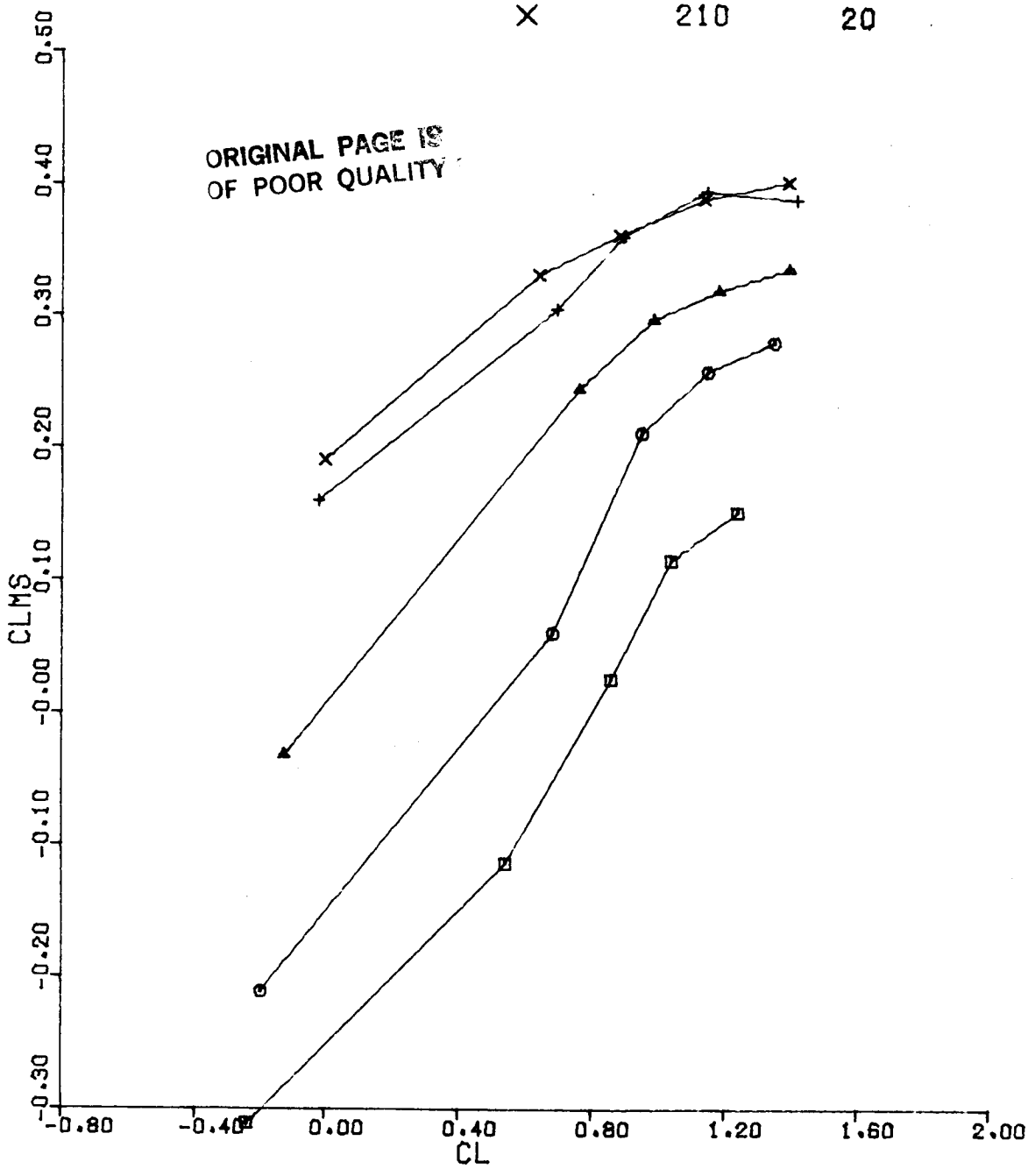

Figure 56(c). CLMS vs CL
Configuration 5, BETA = 0, MACH = 0.9

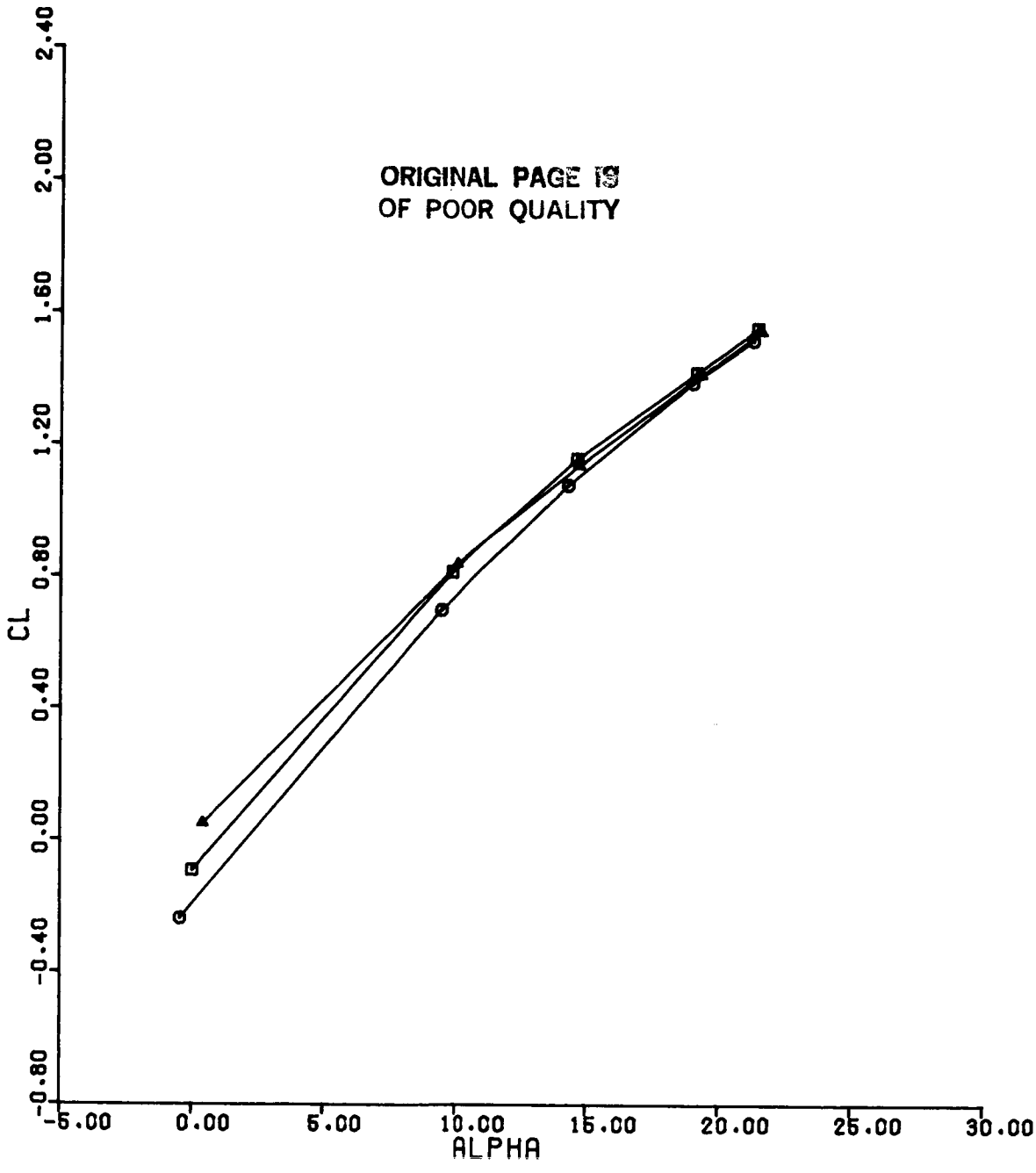

Figure 57(a). CL vs ALPHA
Configuration 5, BETA = 0, MACH = 1.2

SYMBOL	RUN	DC
□	211	0
○	212	-10
△	213	10

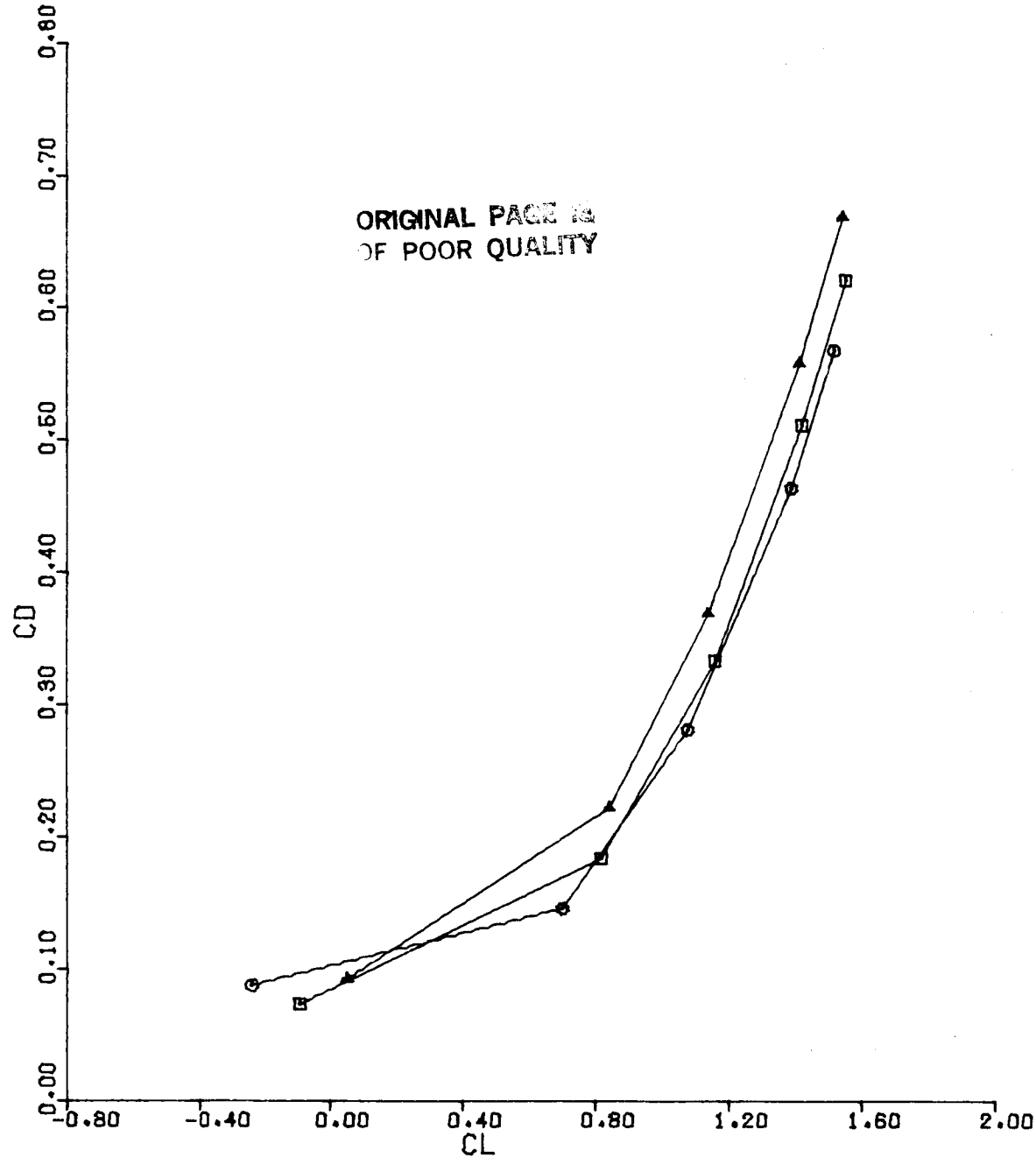

Figure 57(b). CD vs CL
Configuration 5, BETA = 0, MACH = 1.2

SYMBOL	RUN	DC
□	211	0
○	212	-10
△	213	10

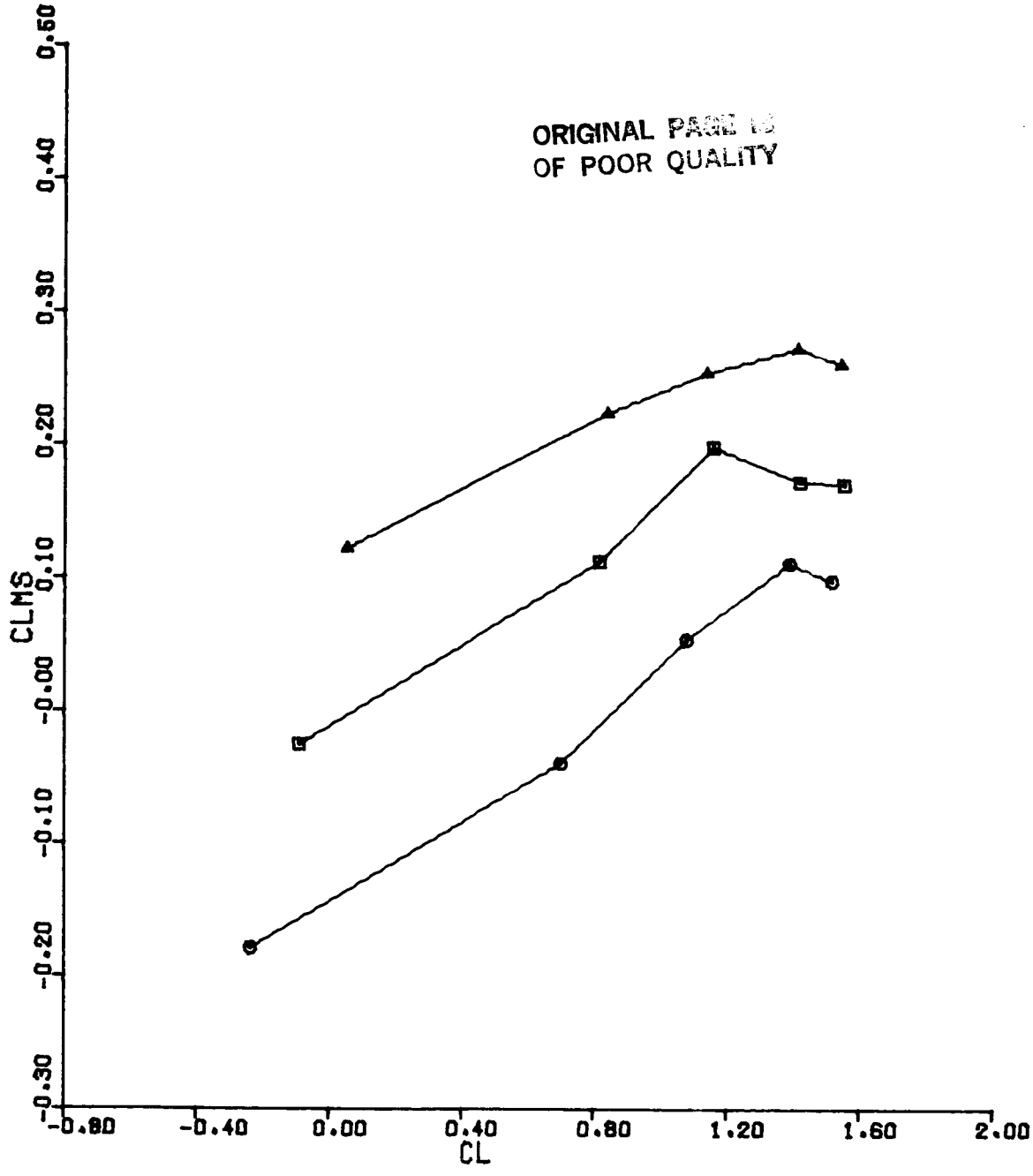

Figure 57(c). CLMS vs CL
Configuration 5, BETA = 0, MACH = 1.2

SYMBOL	RUN	MACH
⊡	195	0.6
⊙	206	0.9
△	211	1.2

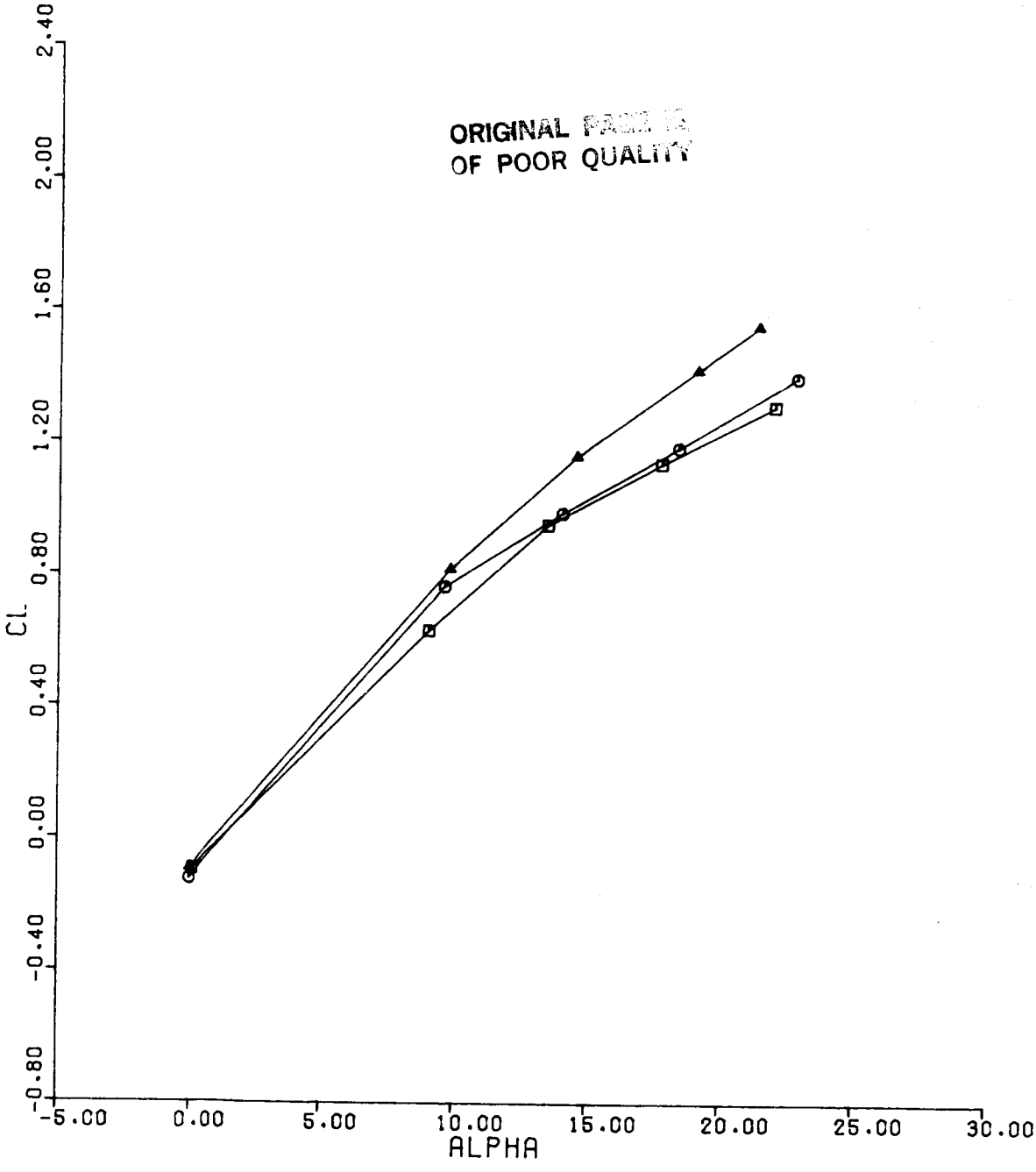

Figure 58(a). CL vs ALPHA
Configuration 5, BETA = 0, DC = 0

SYMBOL	RUN	MACH
□	195	0.6
○	206	0.9
△	211	1.2

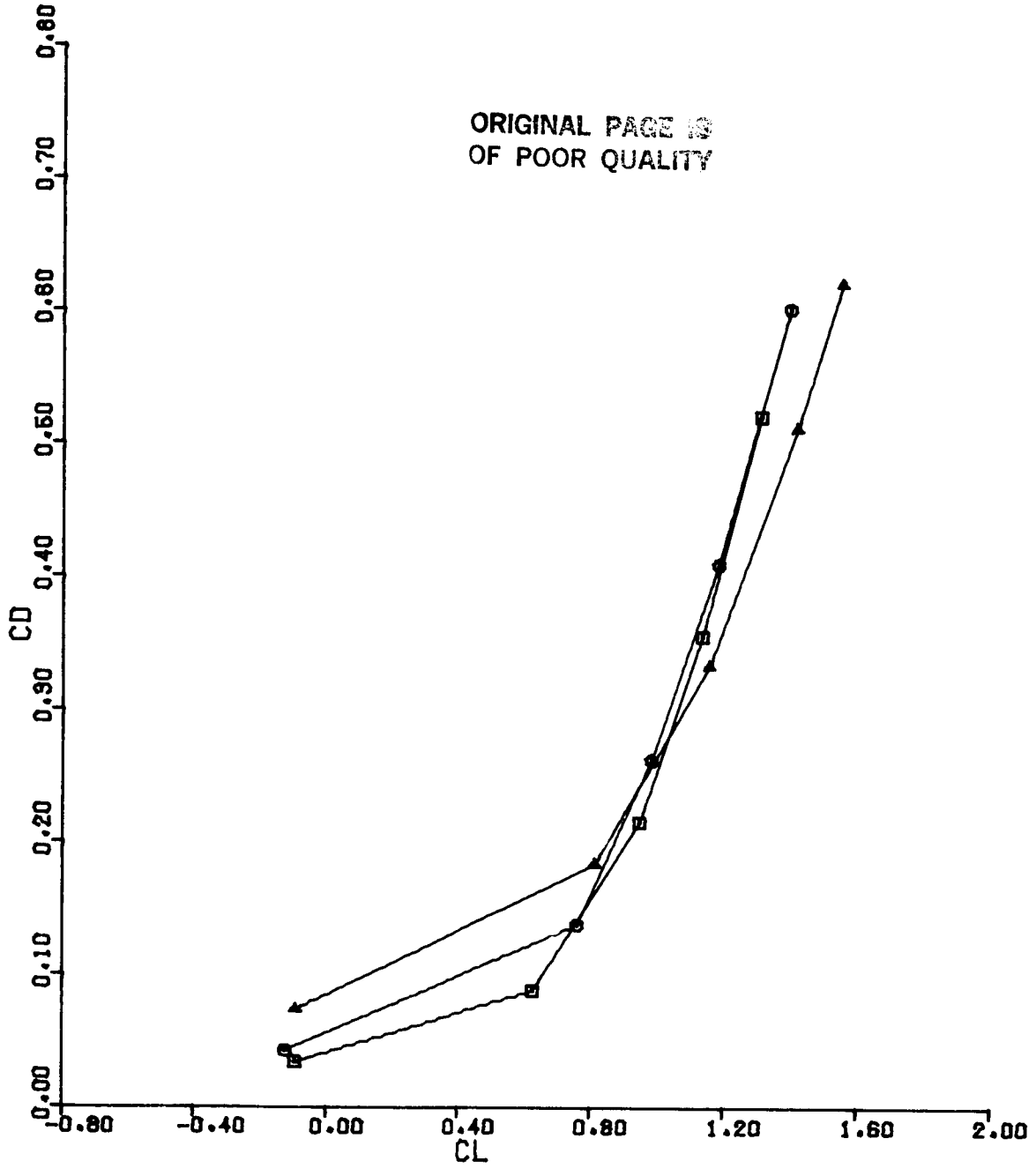

Figure 58(b). CD vs CL
Configuration 5, BETA = 0, DC = 0

SYMBOL	RUN	MACH
□	195	0.6
○	206	0.9
△	211	1.2

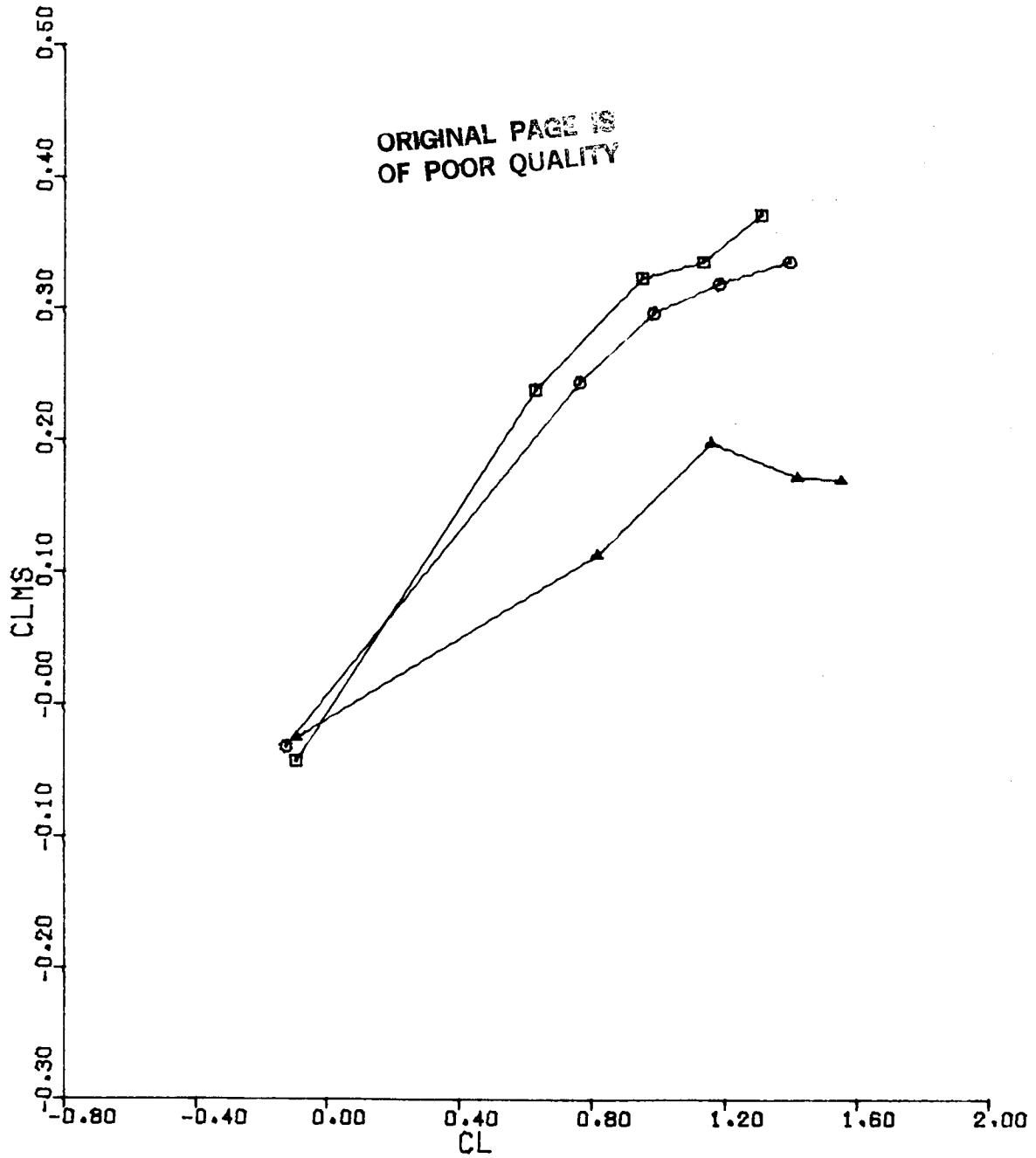

Figure 58(c). CLMS vs CL
Configuration 5, BETA = 0, DC = 0

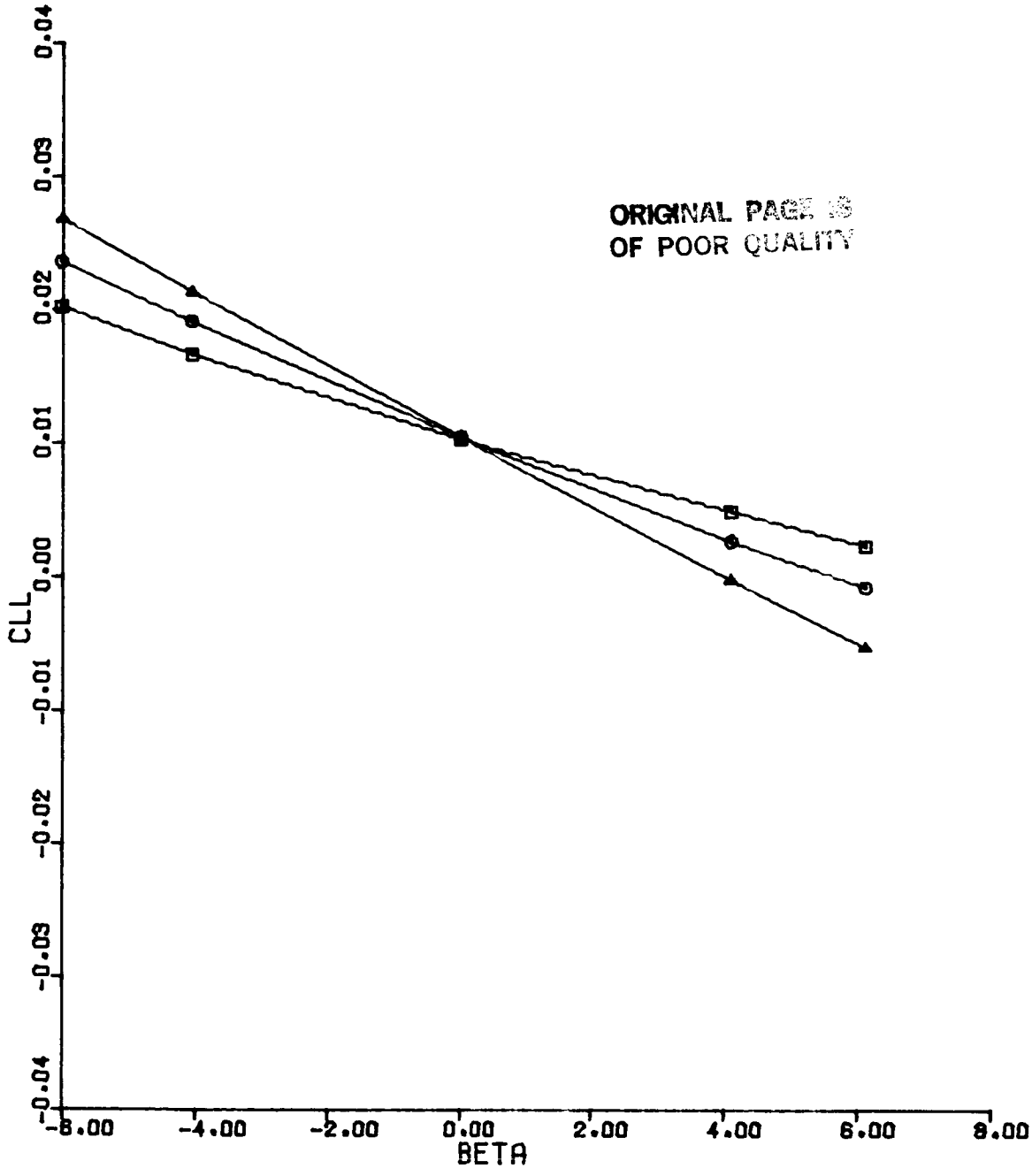

Figure 59(a). CLL vs BETA
Configuration 5, ALPHA = 10, MACH = 0.6

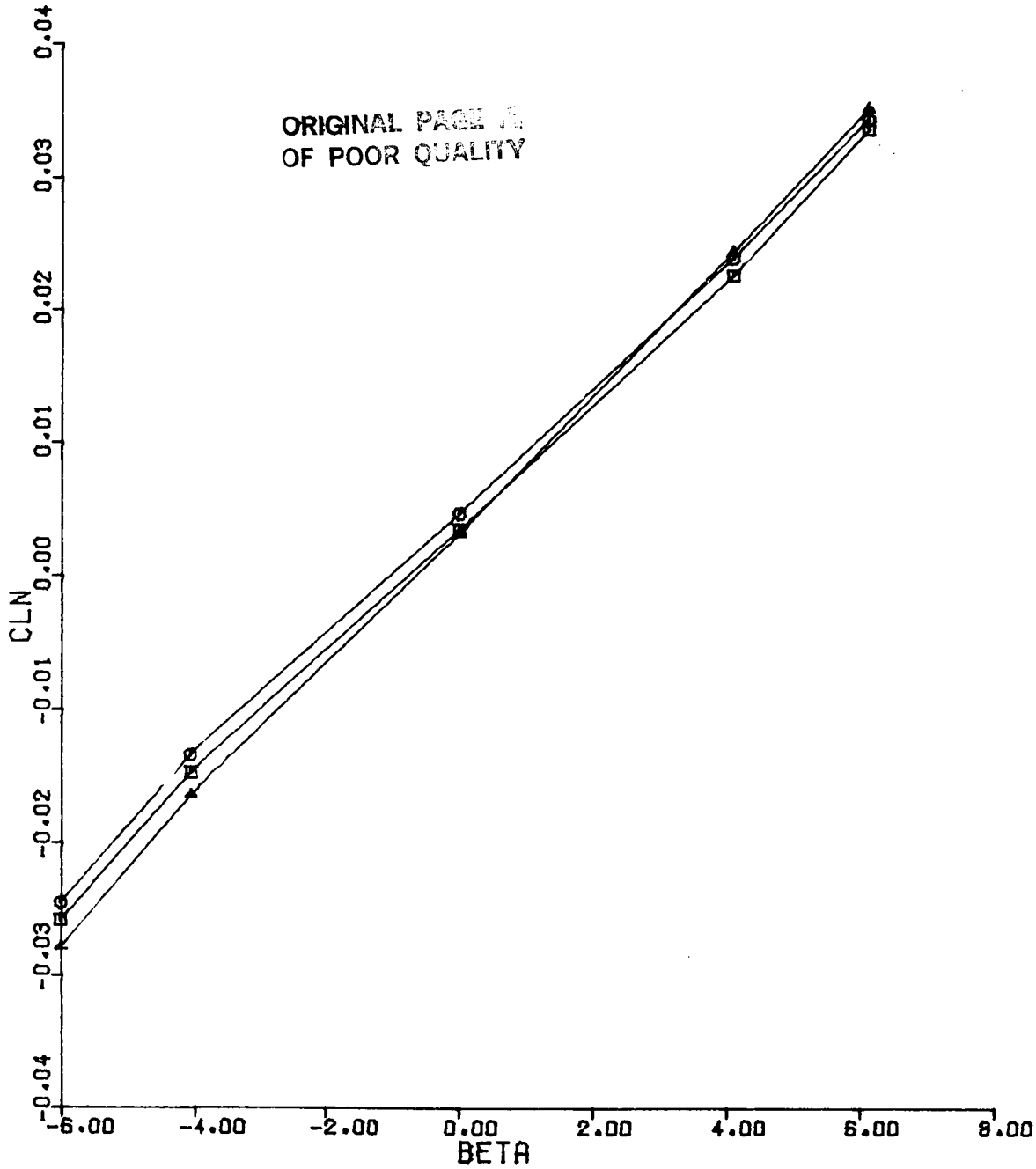

Figure 59(b). CLN vs BETA
Configuration 5, ALPHA = 10, MACH = 0.6

SYMBOL	RUN	DC
□	191	-10
○	194	0
△	197	10

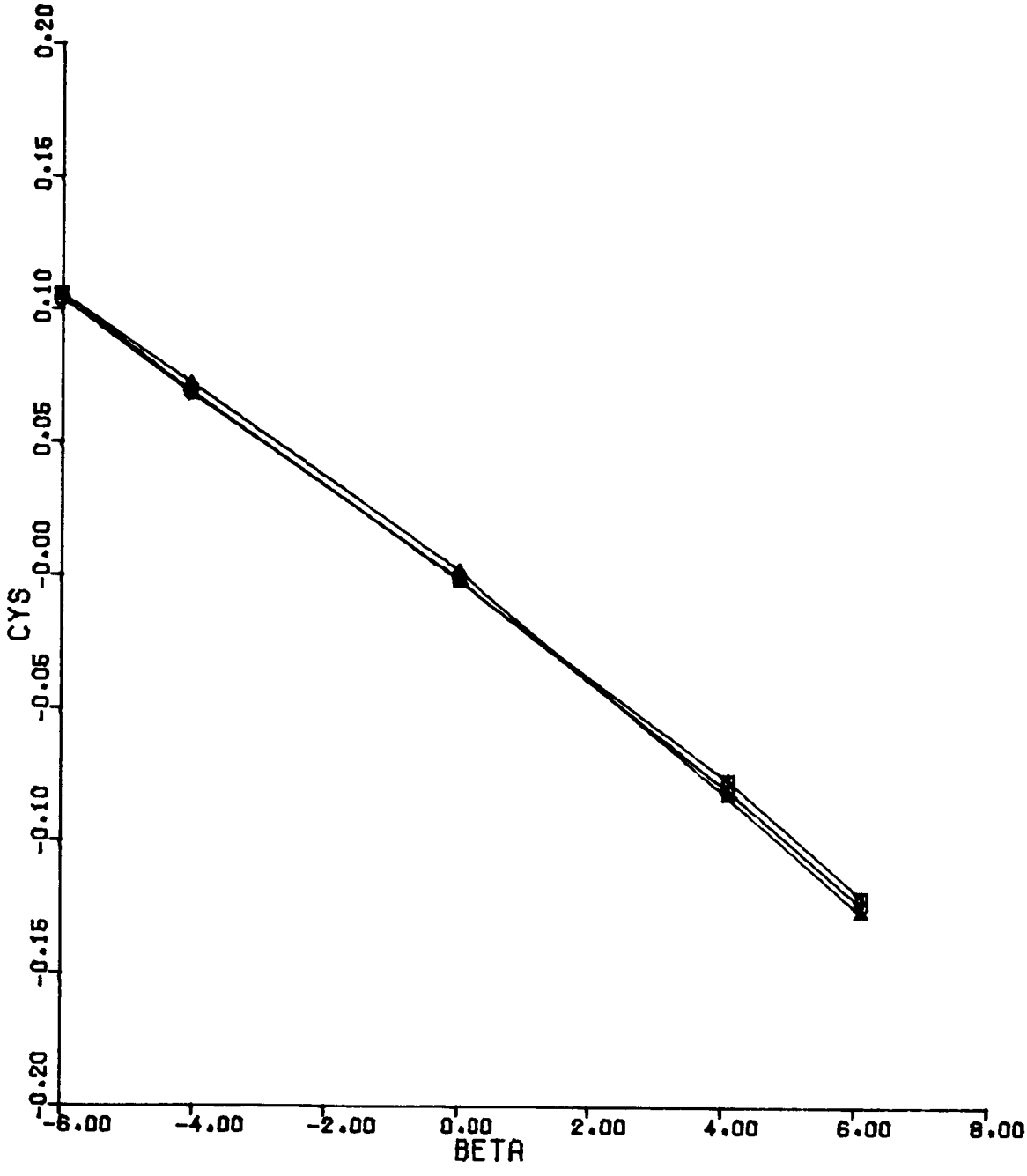

Figure 59(c). CYS vs BETA
Configuration 5, ALPHA = 10, MACH = 0.6

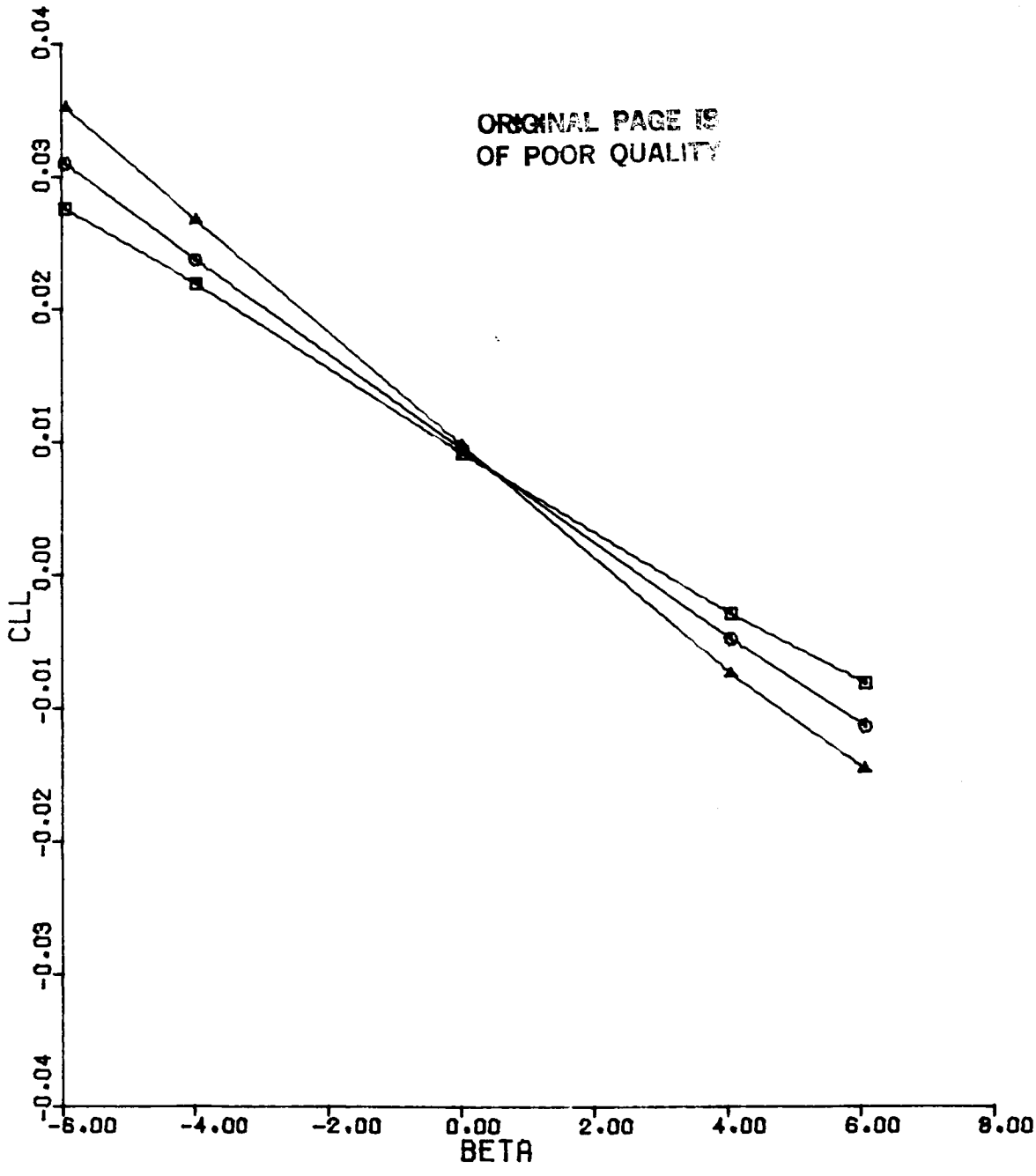

Figure 60(a). CLL vs BETA
Configuration 5, ALPHA = 15, MACH = 0.6

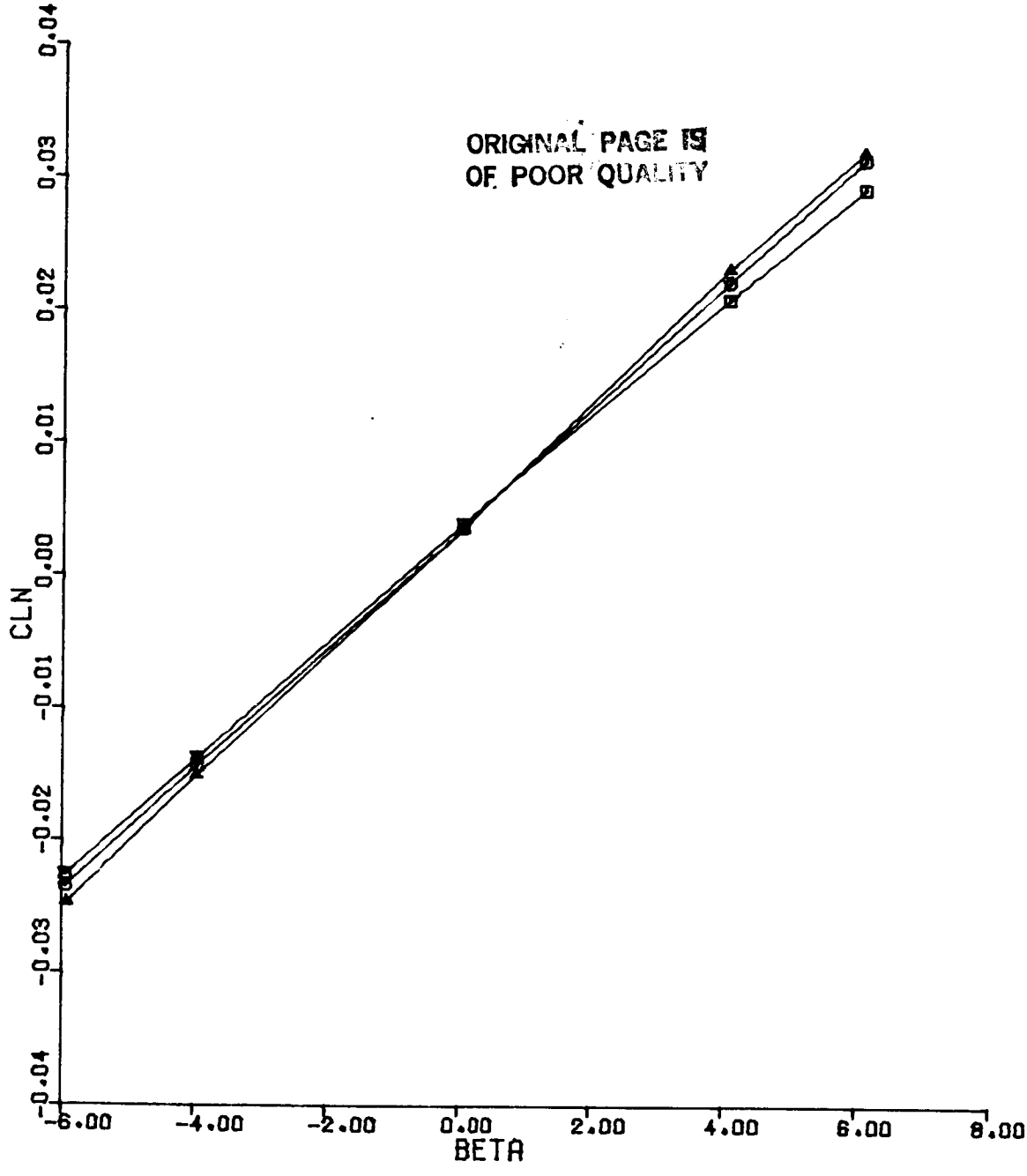

Figure 60(b). CLN vs BETA
Configuration 5, ALPHA = 15, MACH = 0.6

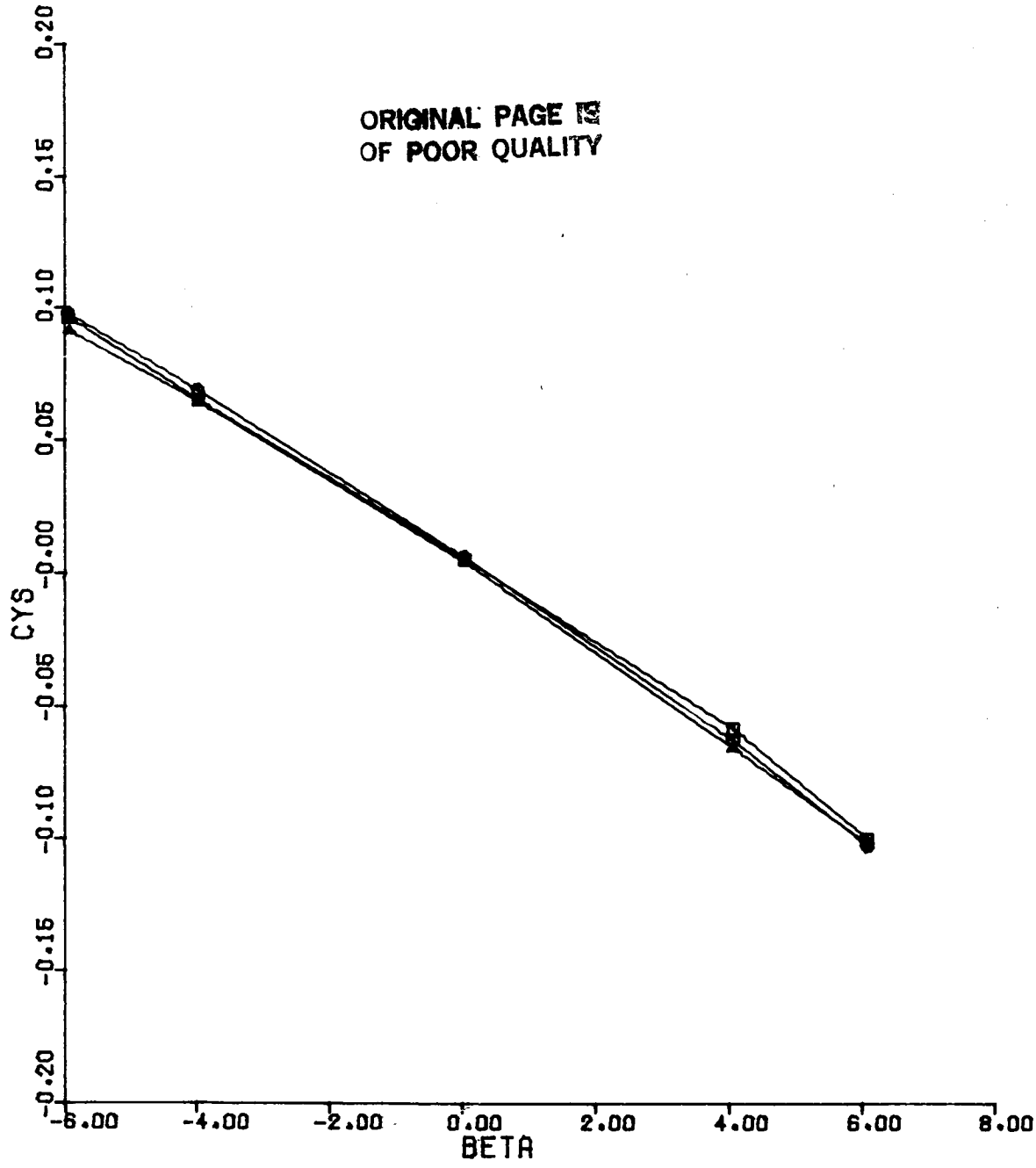

Figure 60(c). CYS vs BETA
Configuration 5, ALPHA = 15, MACH = 0.6

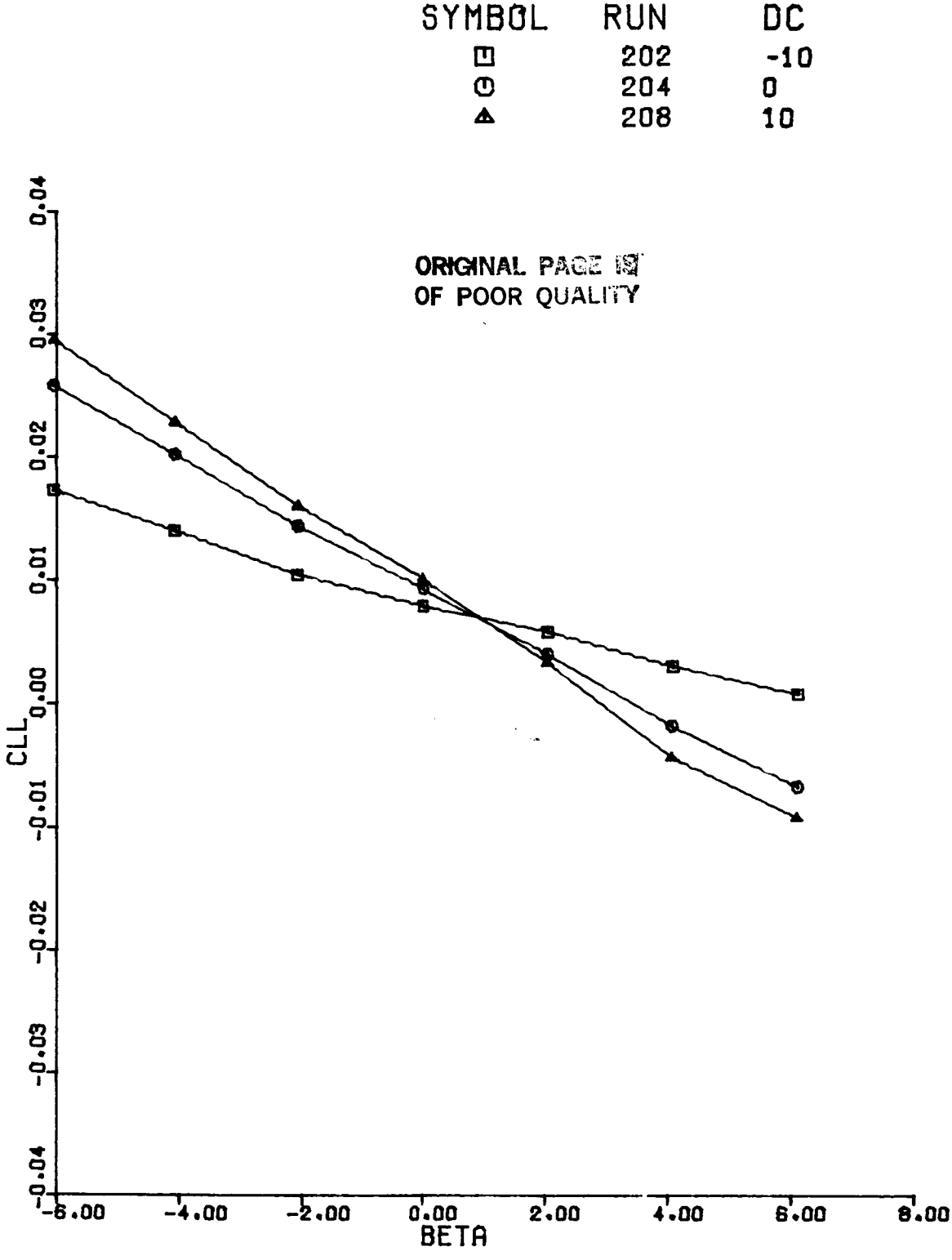

Figure 61(a). CLL vs BETA
Configuration 5, ALPHA = 10, MACH = 0.9

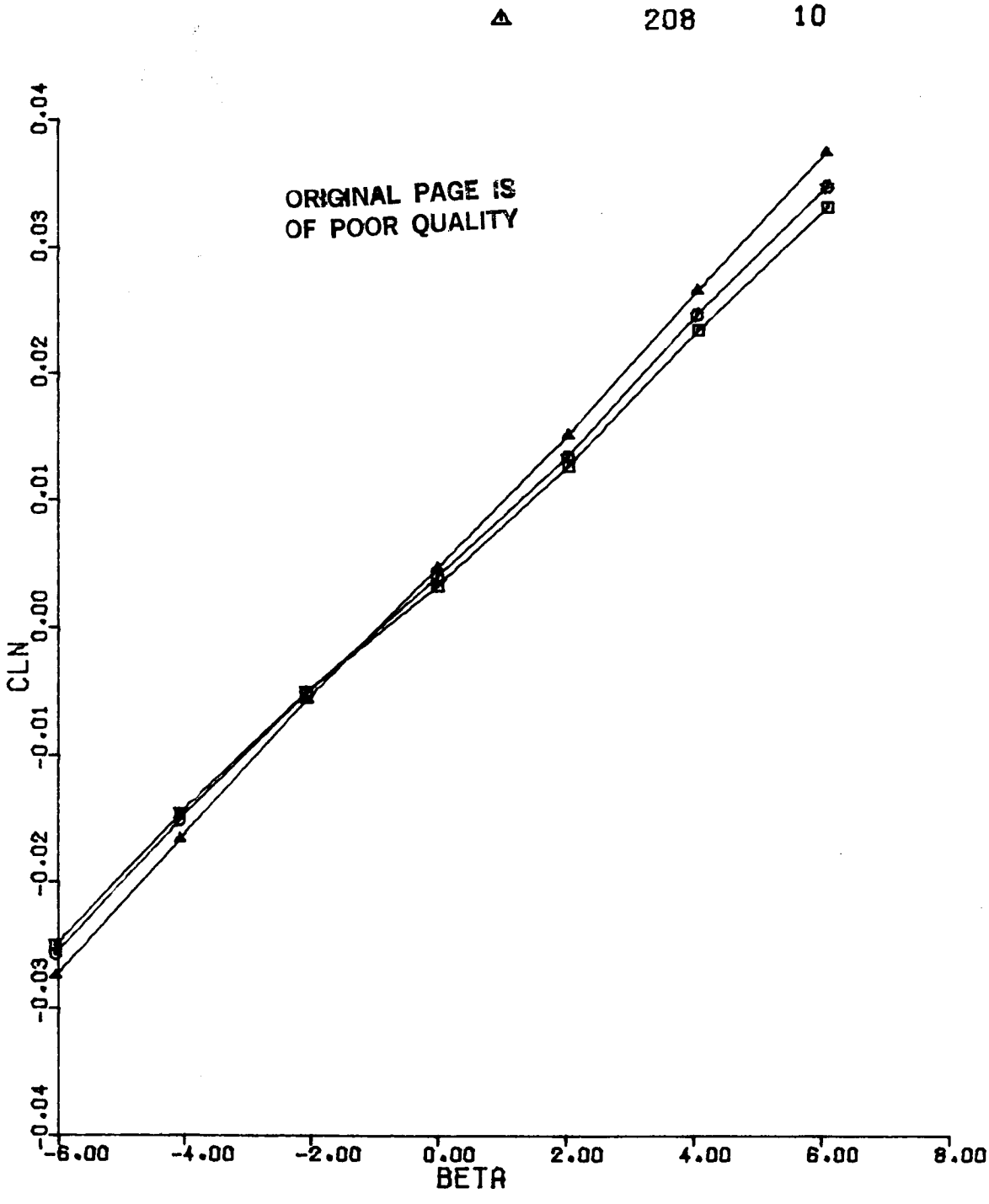

Figure 61(b). CLN vs BETA
Configuration 5, ALPHA = 10, MACH = 0.9

SYMBOL	RUN	DC
□	202	-10
○	204	0
△	208	10

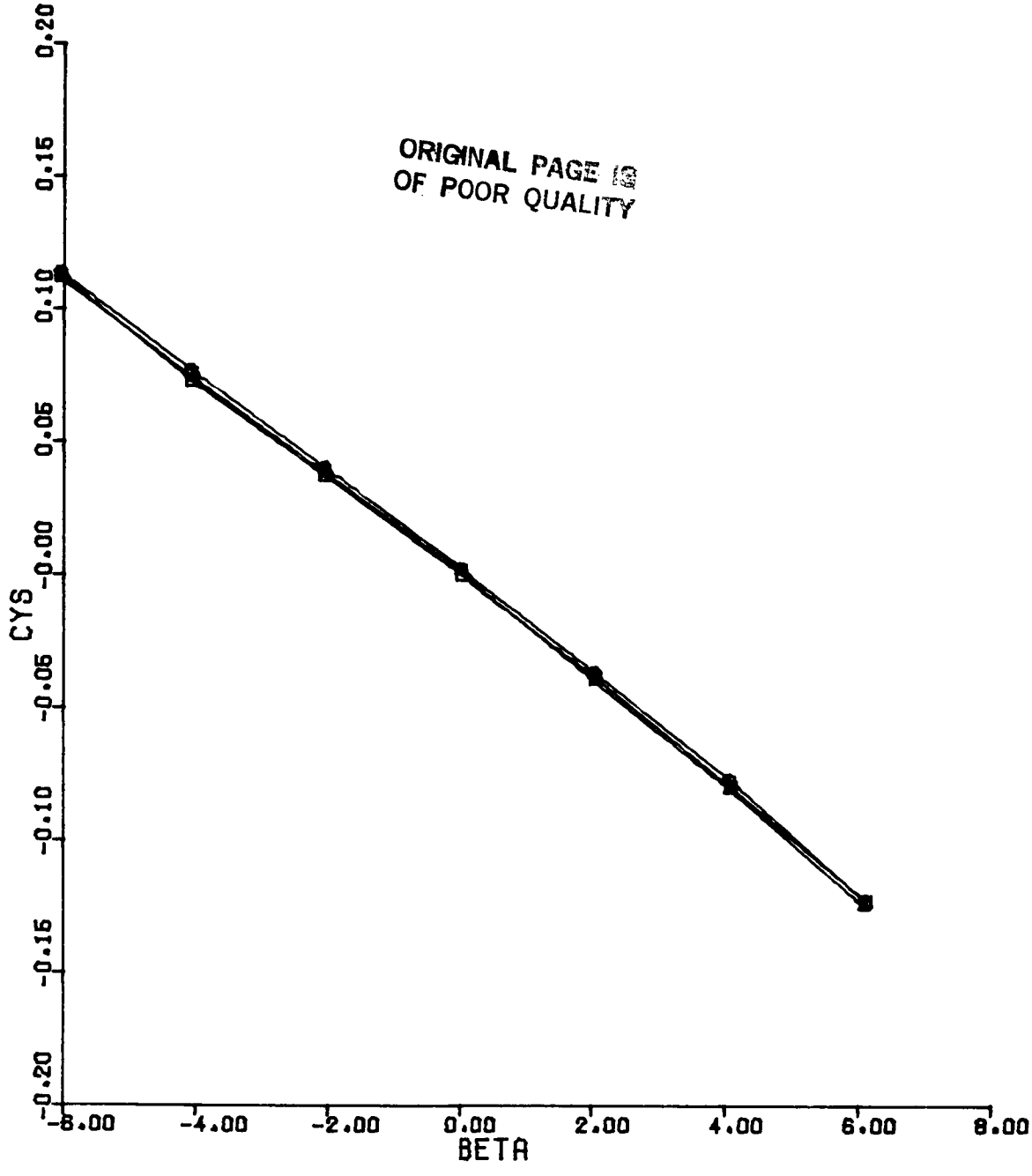

Figure 61(c). CYS vs BETA
Configuration 5, ALPHA = 10, MACH = 0.9

C-3

SYMBOL	RUN	DC
□	203	-10
○	205	0
△	209	10

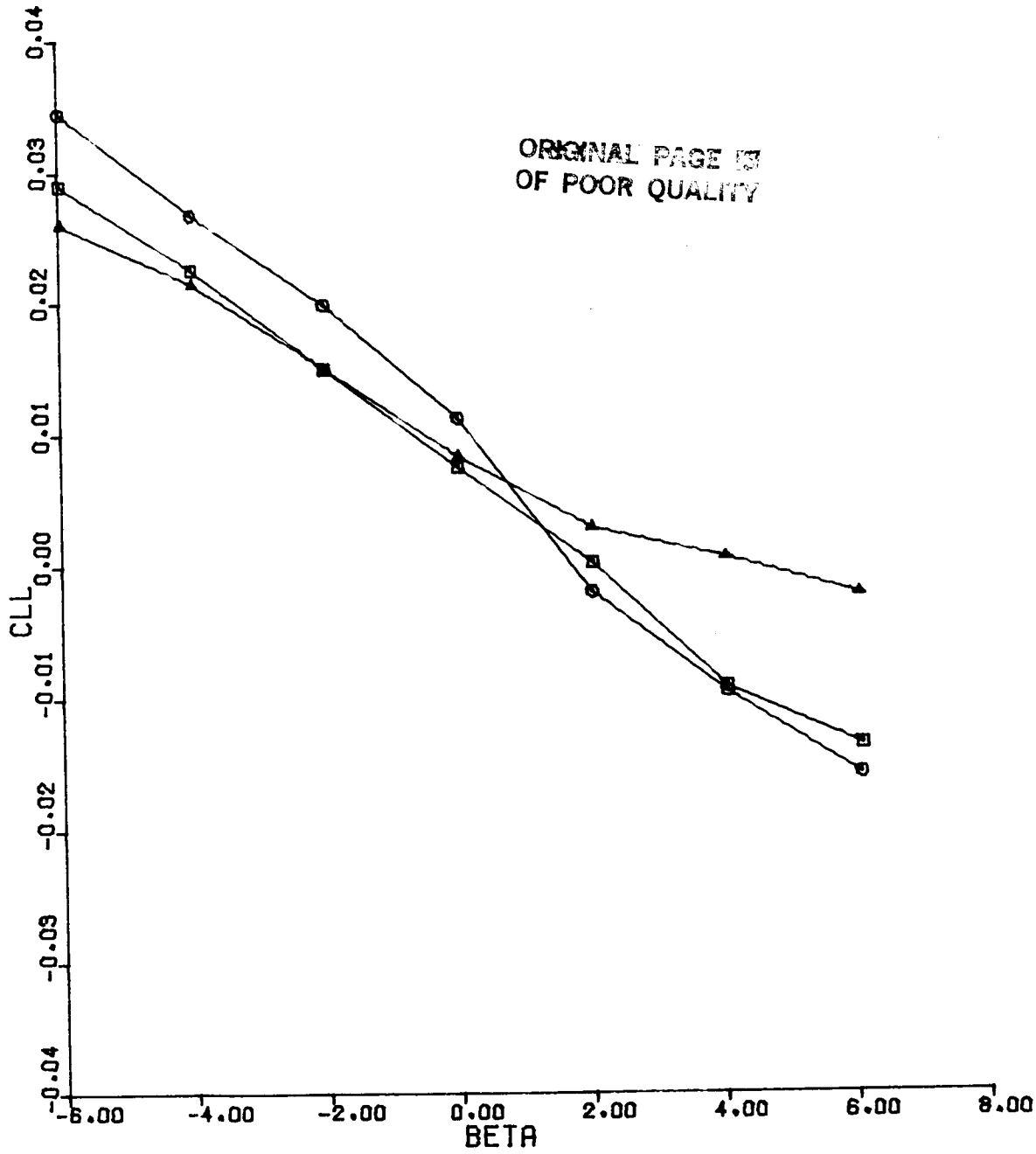

Figure 62(a). CLL vs BETA
Configuration 5, ALPHA = 15, MACH = 0.9

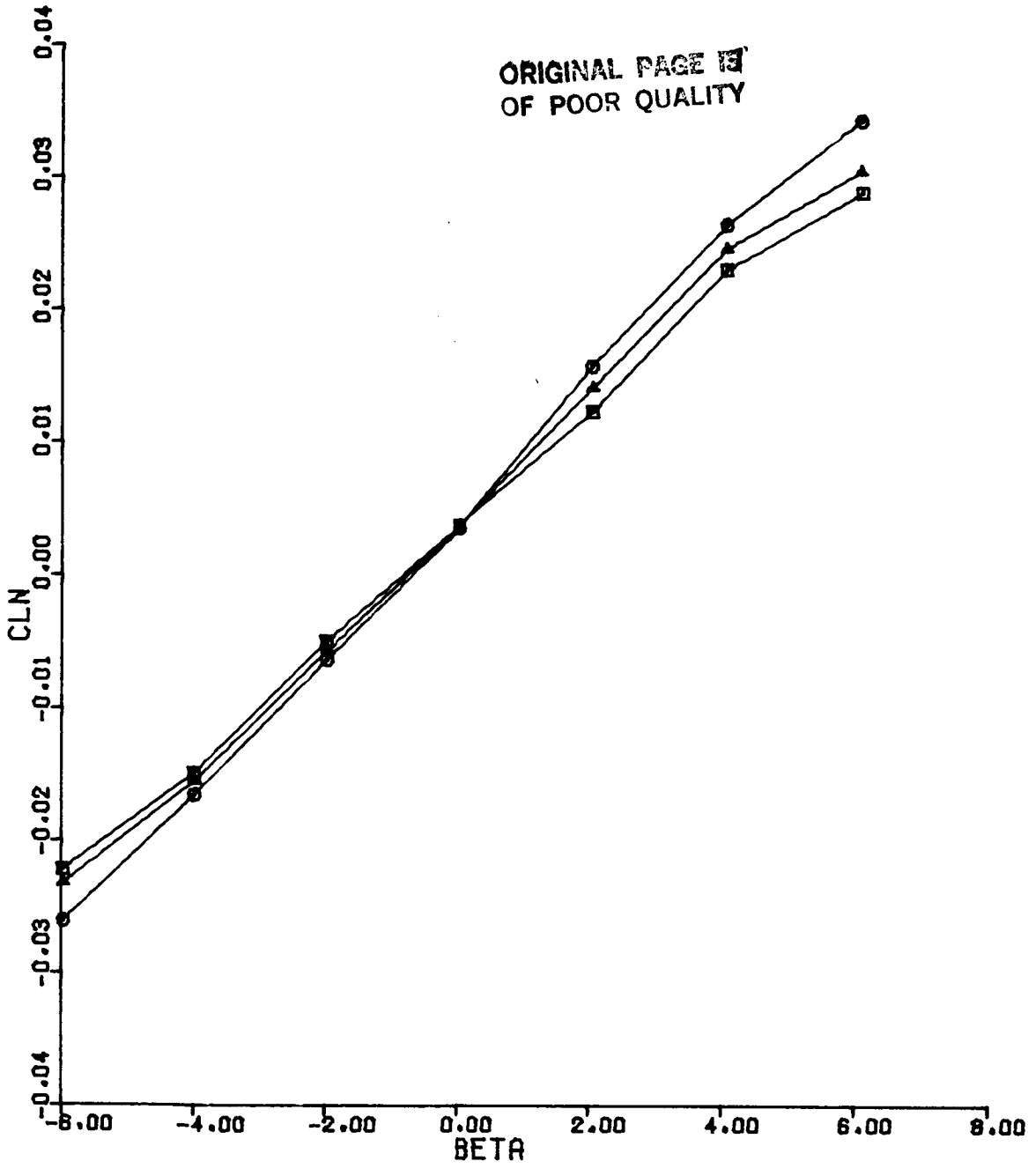

Figure 62(b). CLN vs BETA
Configuration 5, ALPHA = 15, MACH = 0.9

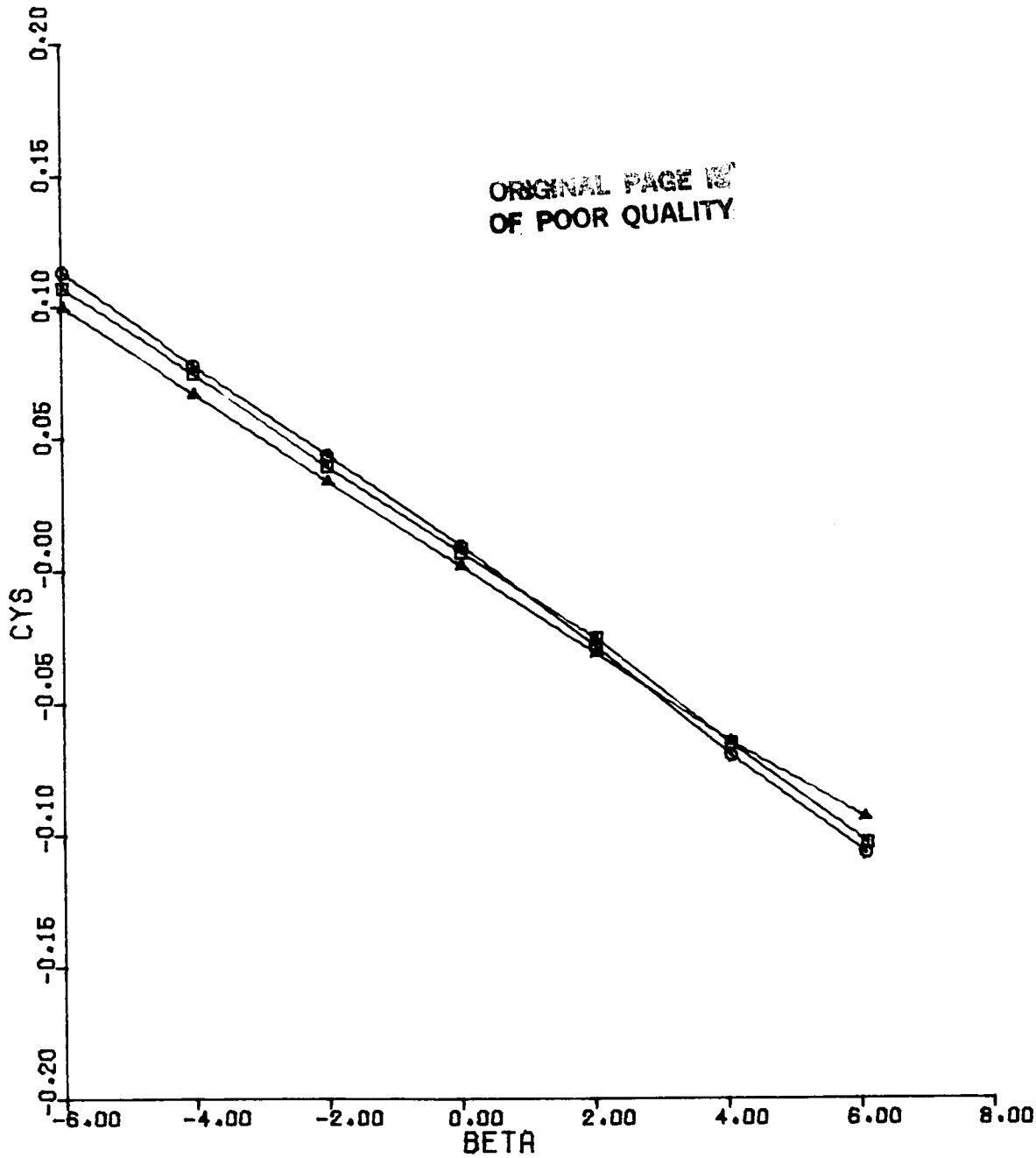

Figure 62(c). CYS vs BETA
Configuration 5, ALPHA = 15, MACH = 0.9

SYMBOL	RUN	DC
□	215	0
○	216	-10
△	217	10

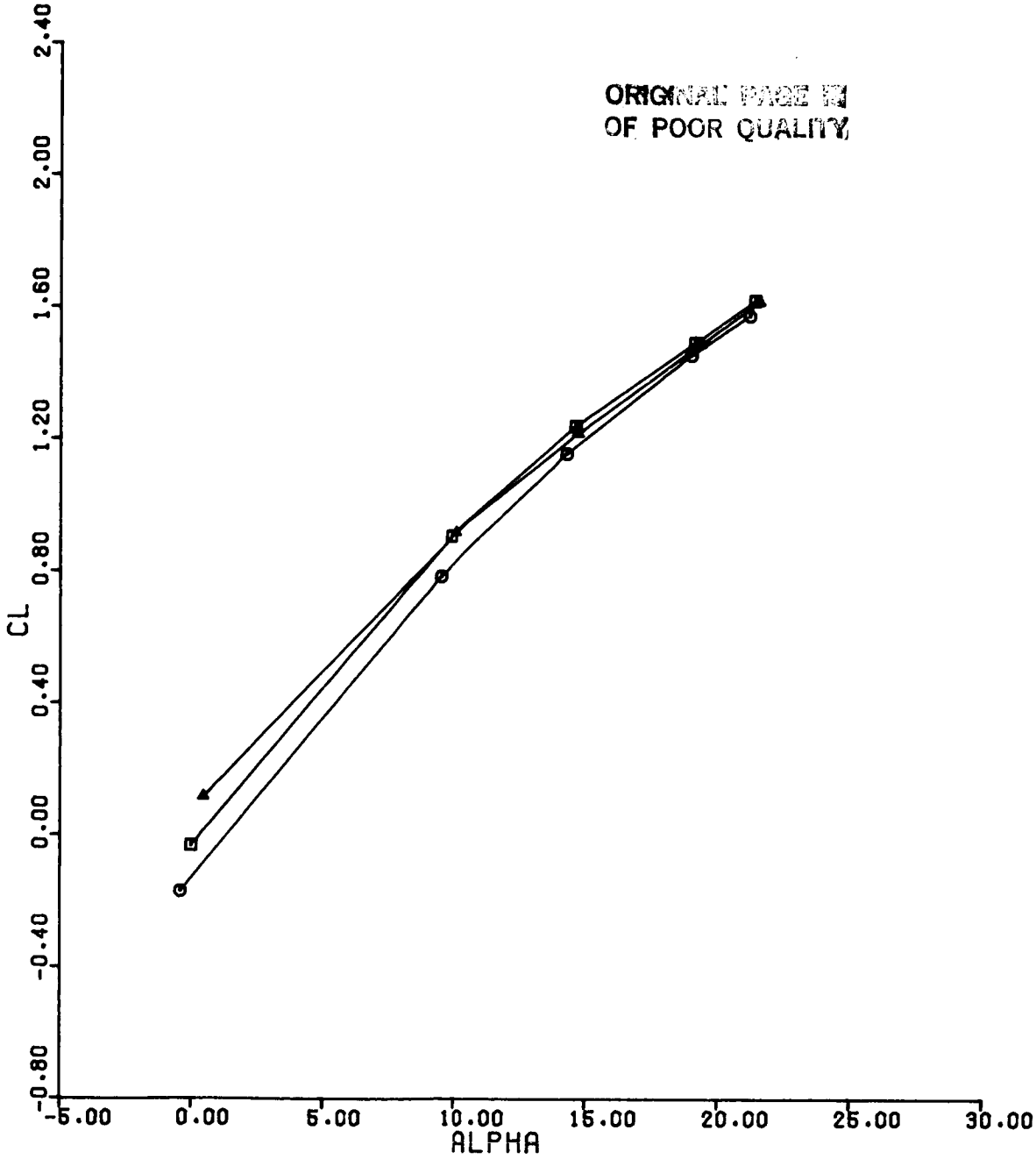

Figure 63(a). CL vs ALPHA
Configuration 6, BETA = 0, MACH = 1.2

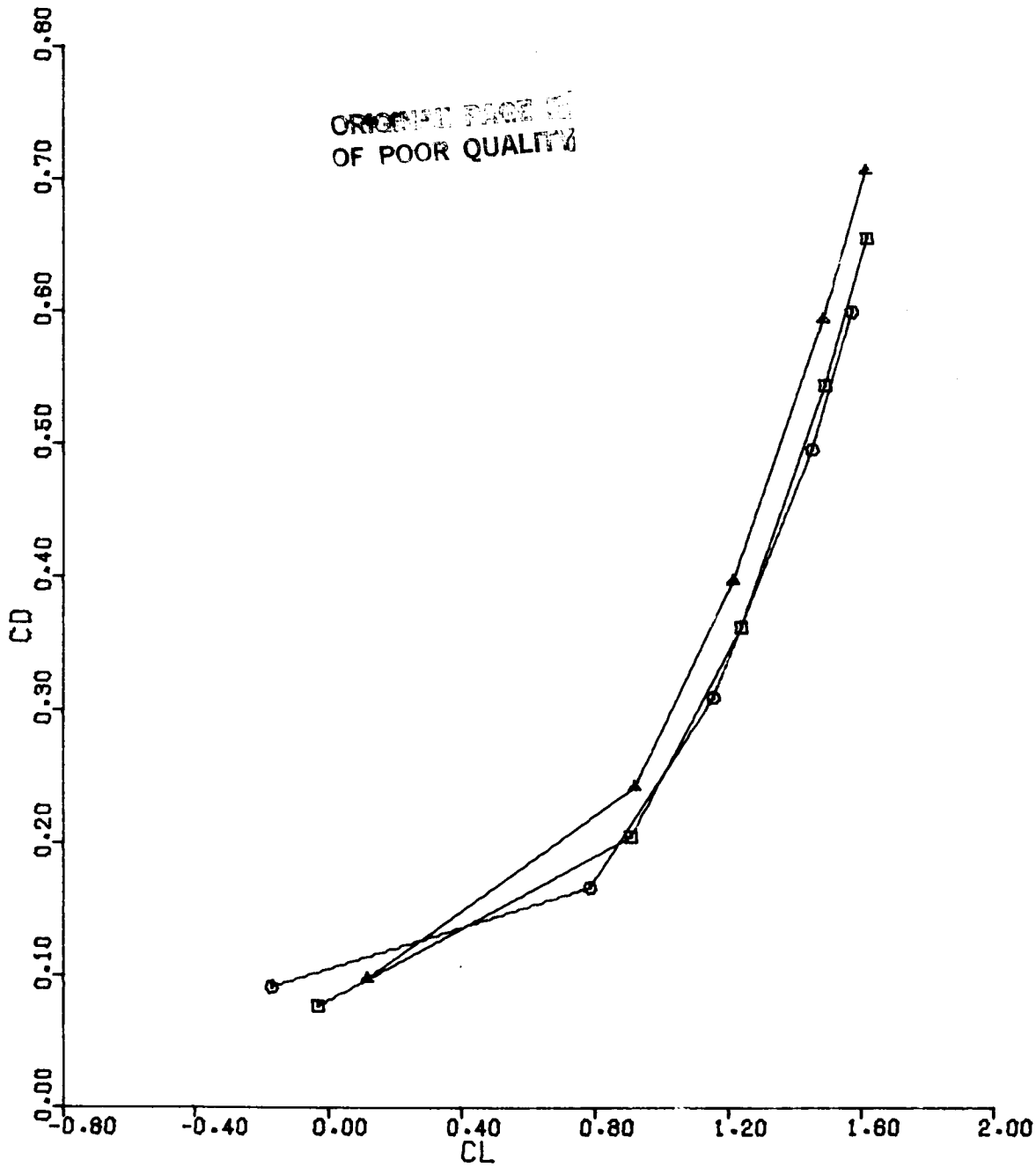

Figure 63(b). CD vs CL
Configuration 6, BETA = 0, MACH = 1.2

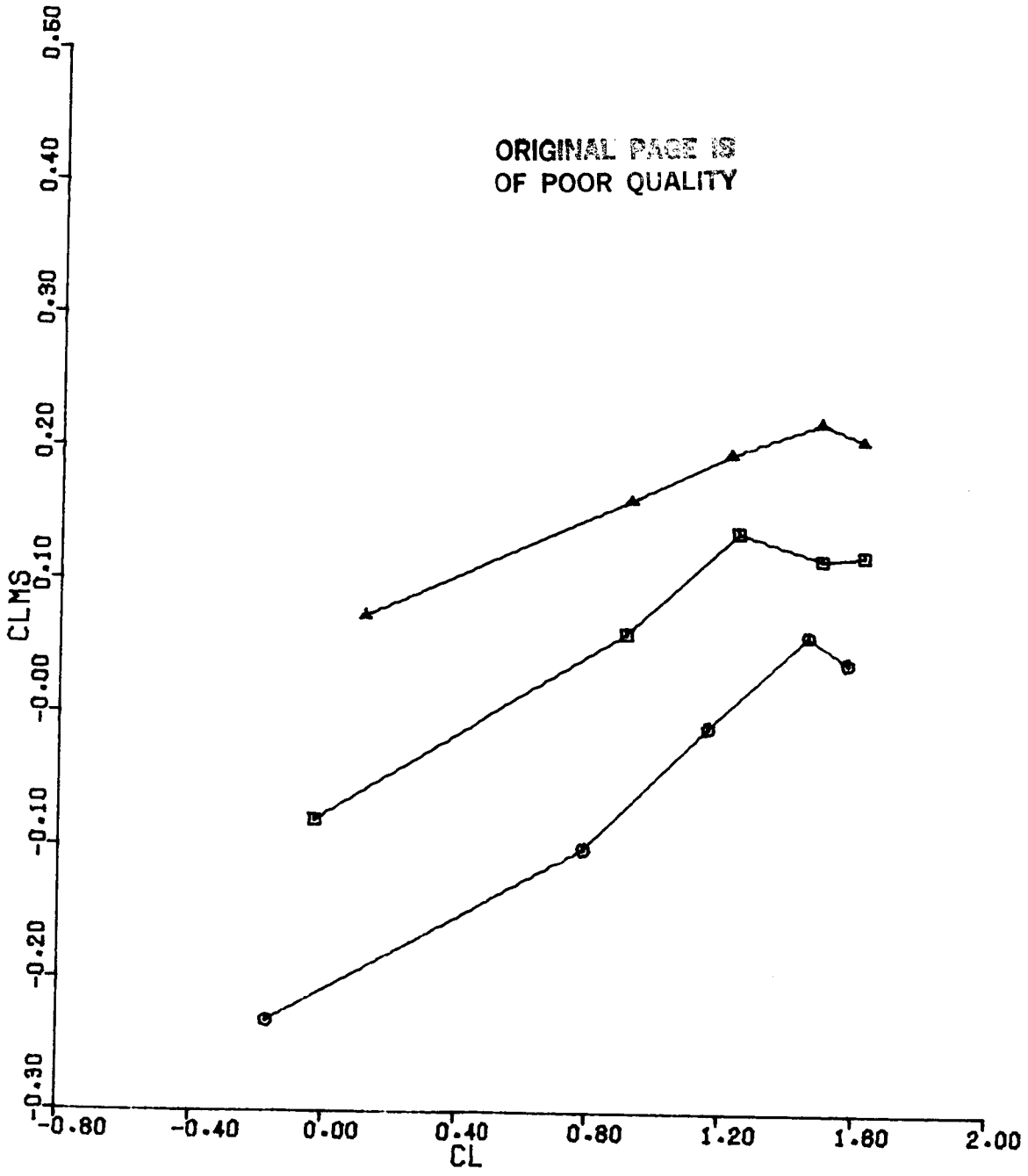

Figure 63(c). CLMS vs CL
Configuration 6, BETA = 0, MACH = 1.2

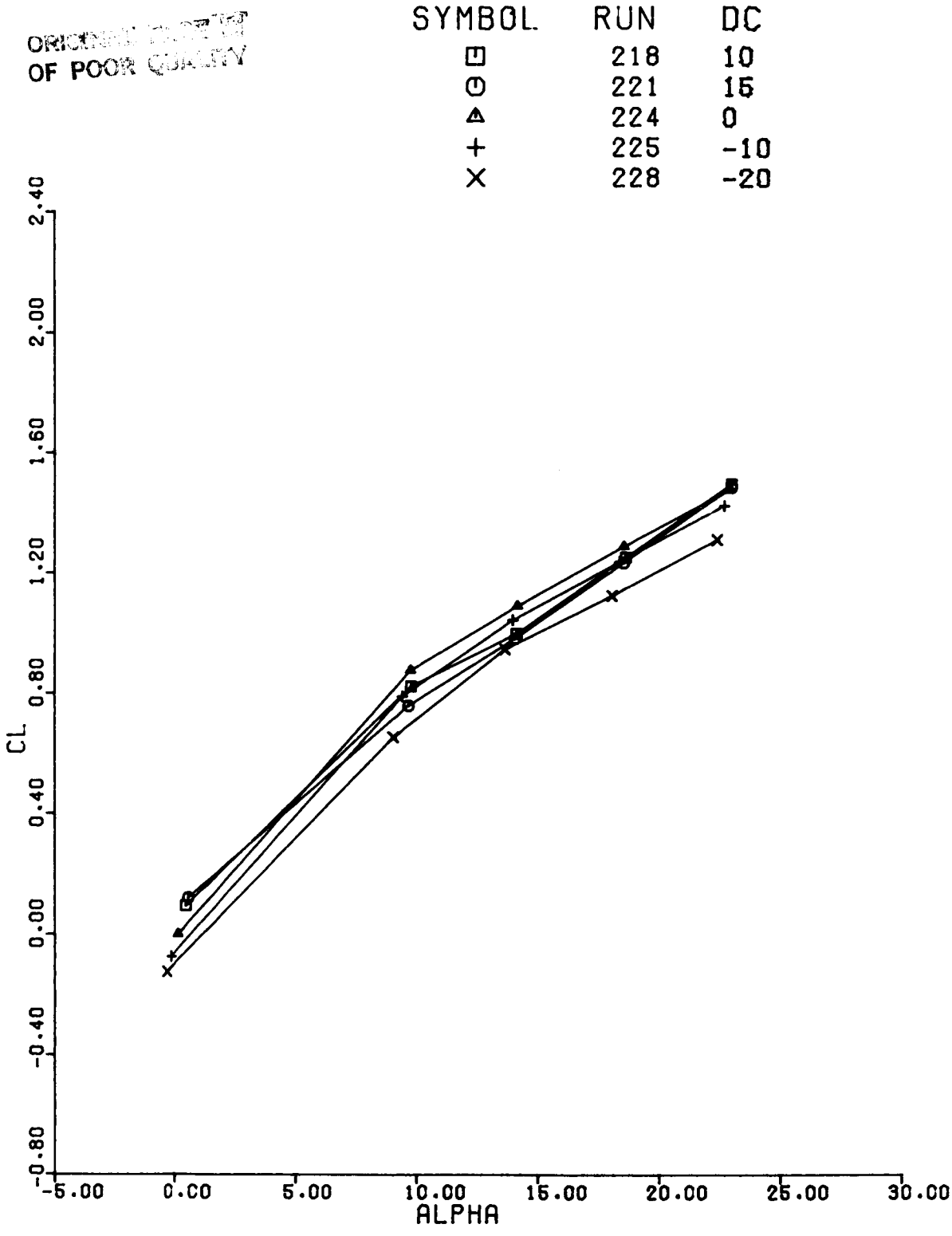

Figure 64(a). CL vs ALPHA
Configuration 6, BETA = 0, MACH = 0.9

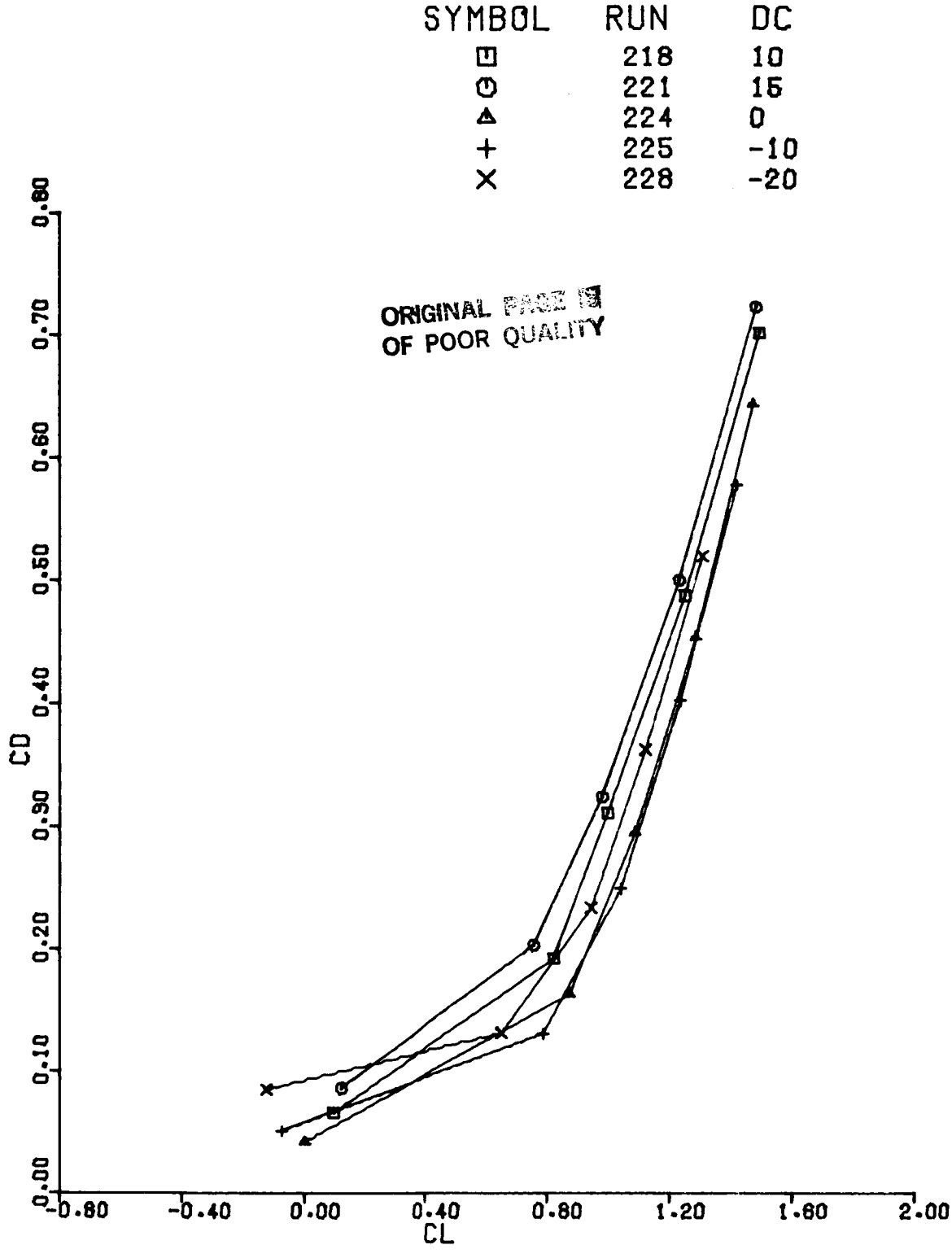

Figure 64(b). CL vs ALPHA
Configuration 6, BETA = 0, MACH = 0.9

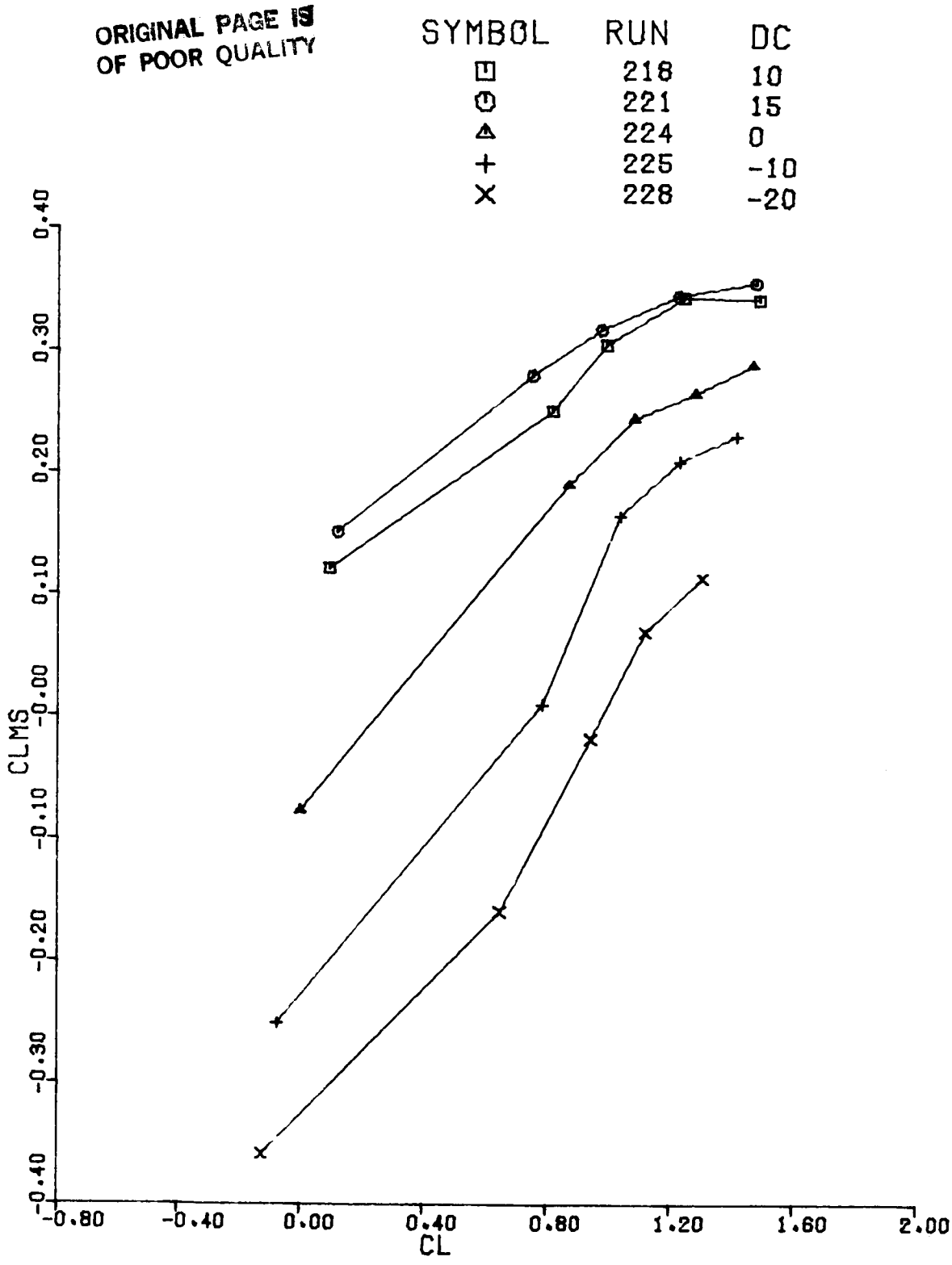

Figure 64(c). CLMS vs CL
Configuration 6, BETA = 0, MACH = 0.9

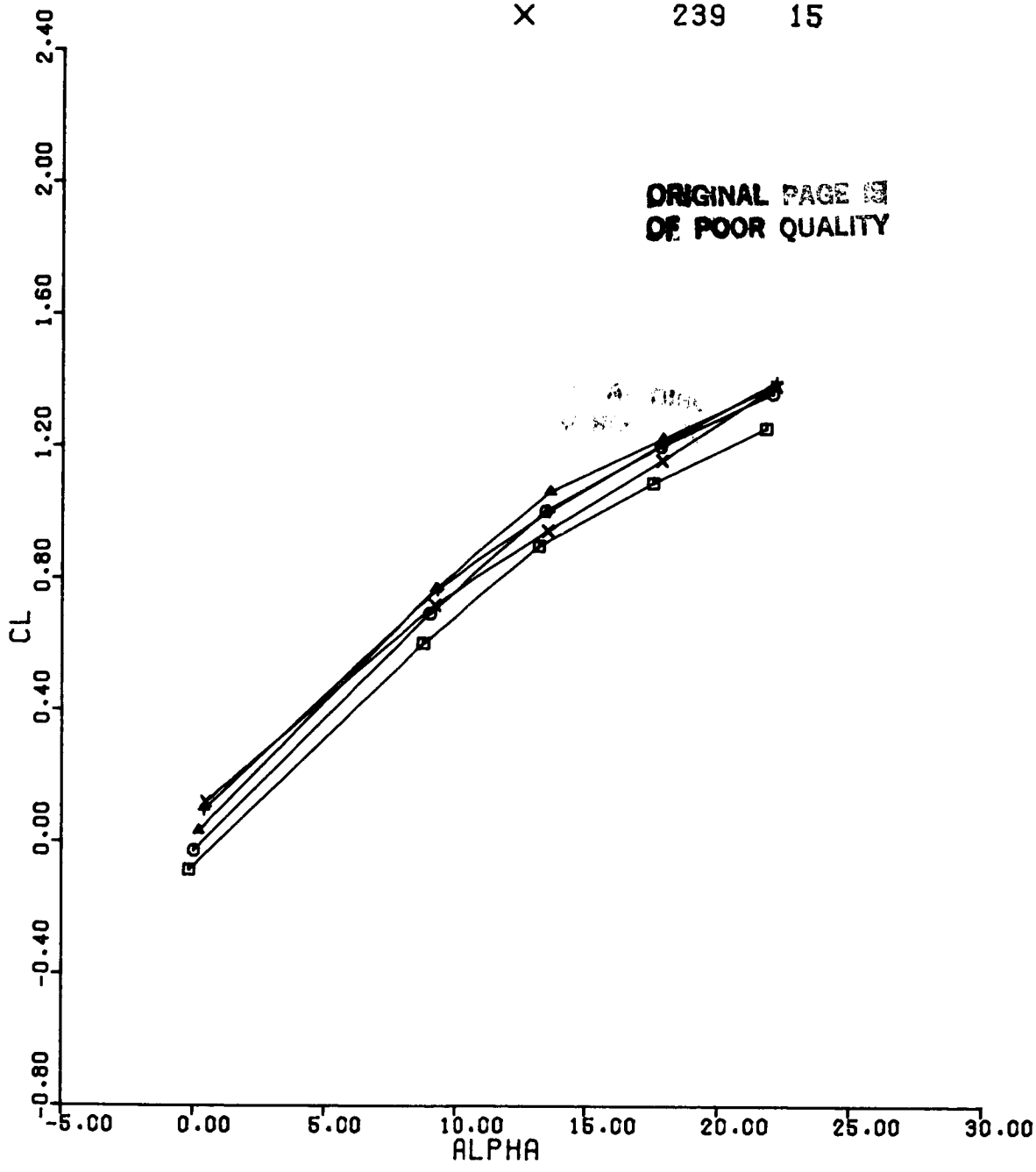

Figure 65(a). CL vs ALPHA
Configuration 6, BETA = 0, MACH = 0.6

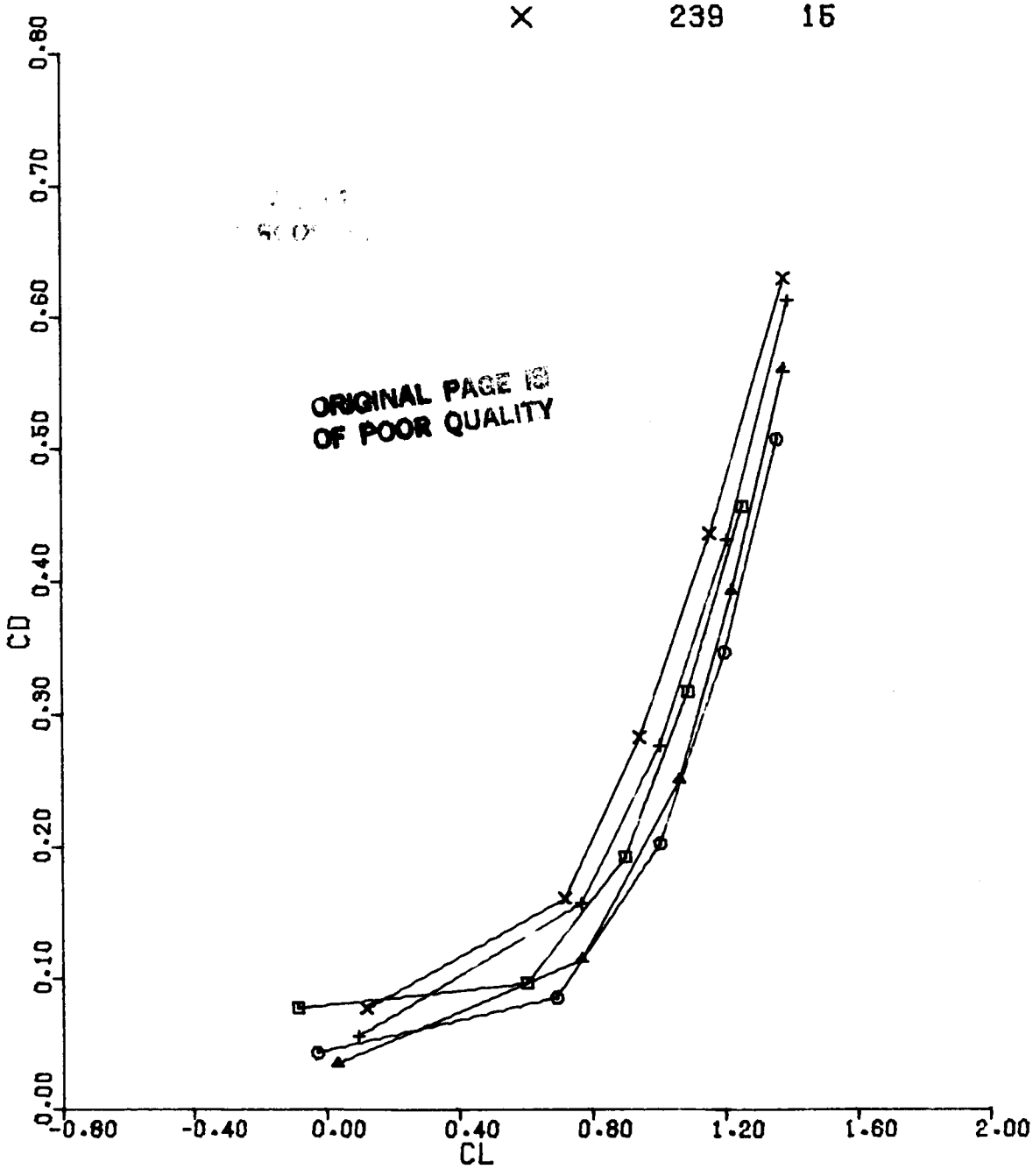

Figure 65(b). CD vs CL
Configuration 6, BETA = 0, MACH = 0.6

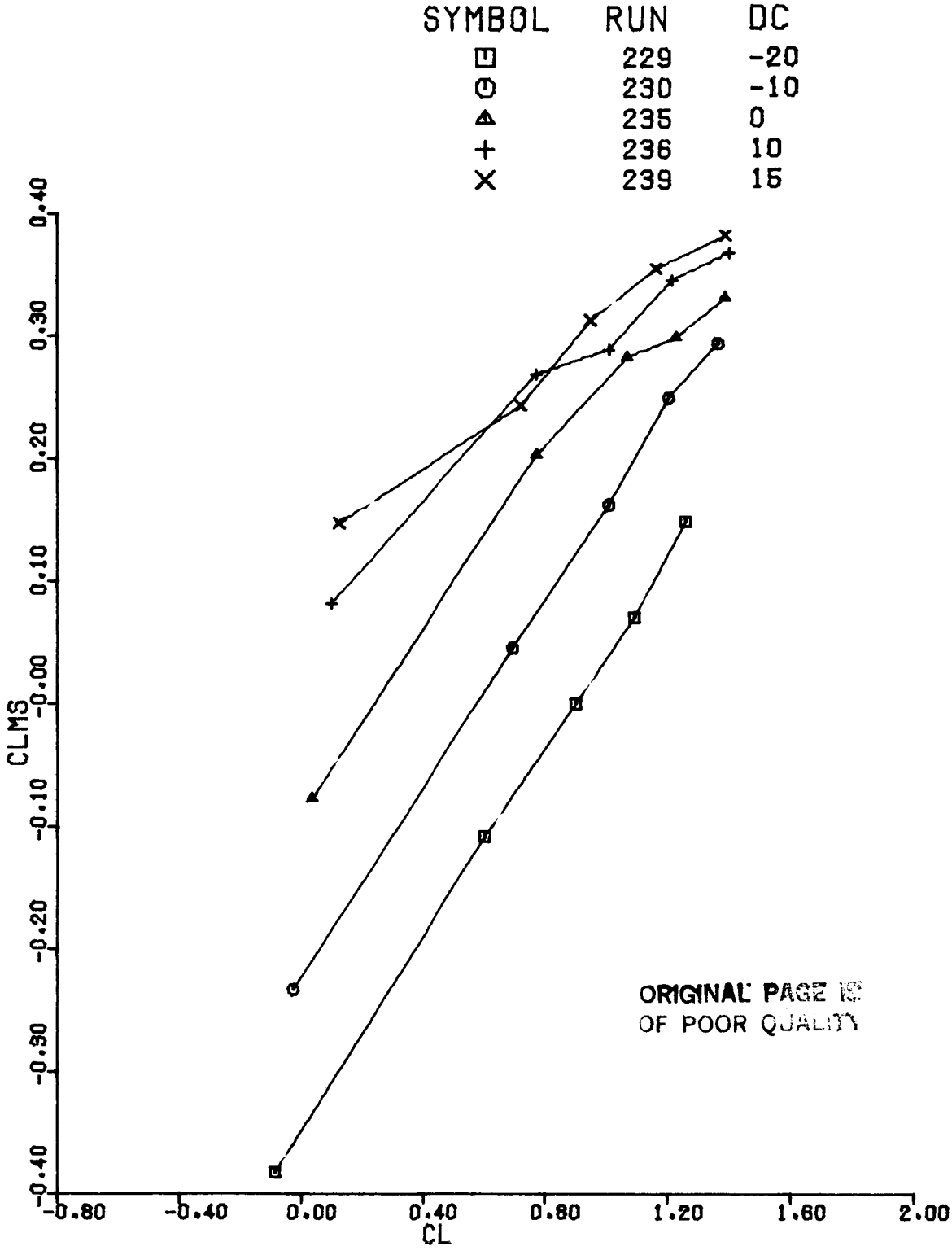

Figure 65(c). CLMS vs CL
Configuration 6, BETA = 0, MACH = 0.6

SYMBOL	RUN	MACH
⊡	215	0.6
⊙	224	0.9
△	235	1.2

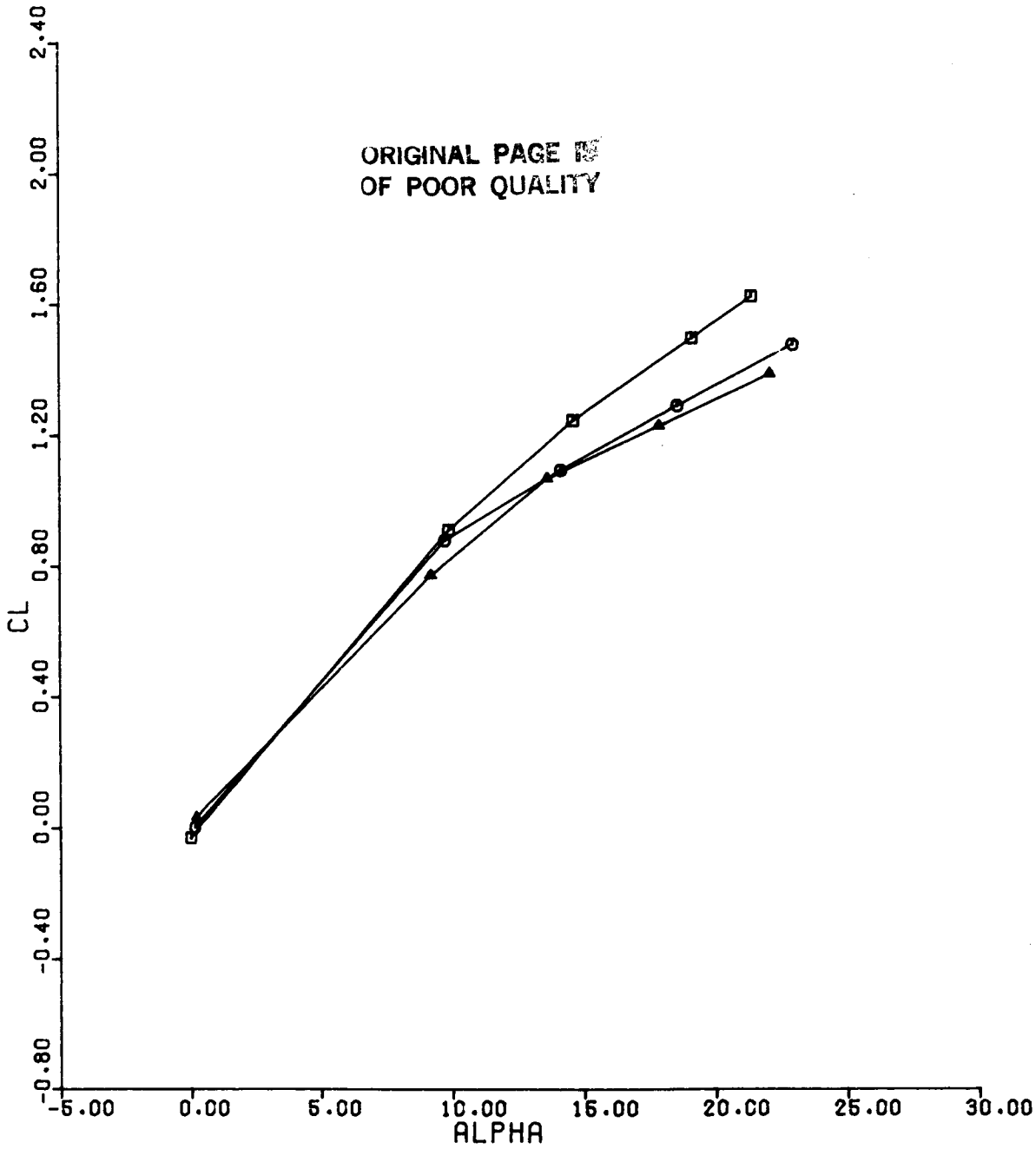

Figure 66(a). CL vs ALPHA
Configuration 6, BETA = 0, DC = 0

SYMBOL	RUN	MACH
□	215	0.6
○	224	0.9
△	235	1.2

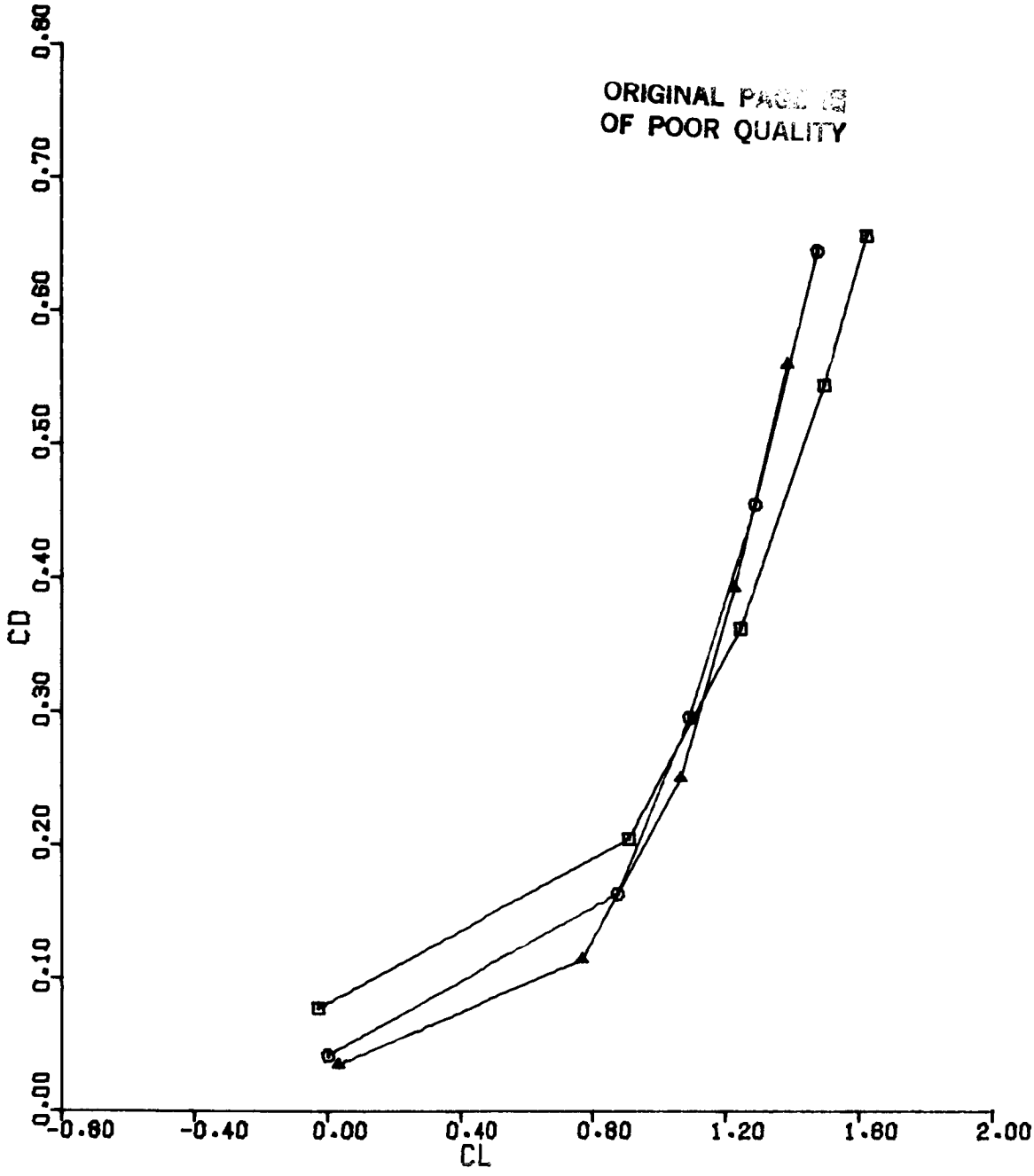

Figure 66(b). CD vs CL
Configuration 6, BETA = 0, DC = 0

SYMBOL	RUN	MACH
⊡	215	0.6
⊙	224	0.9
△	235	1.2

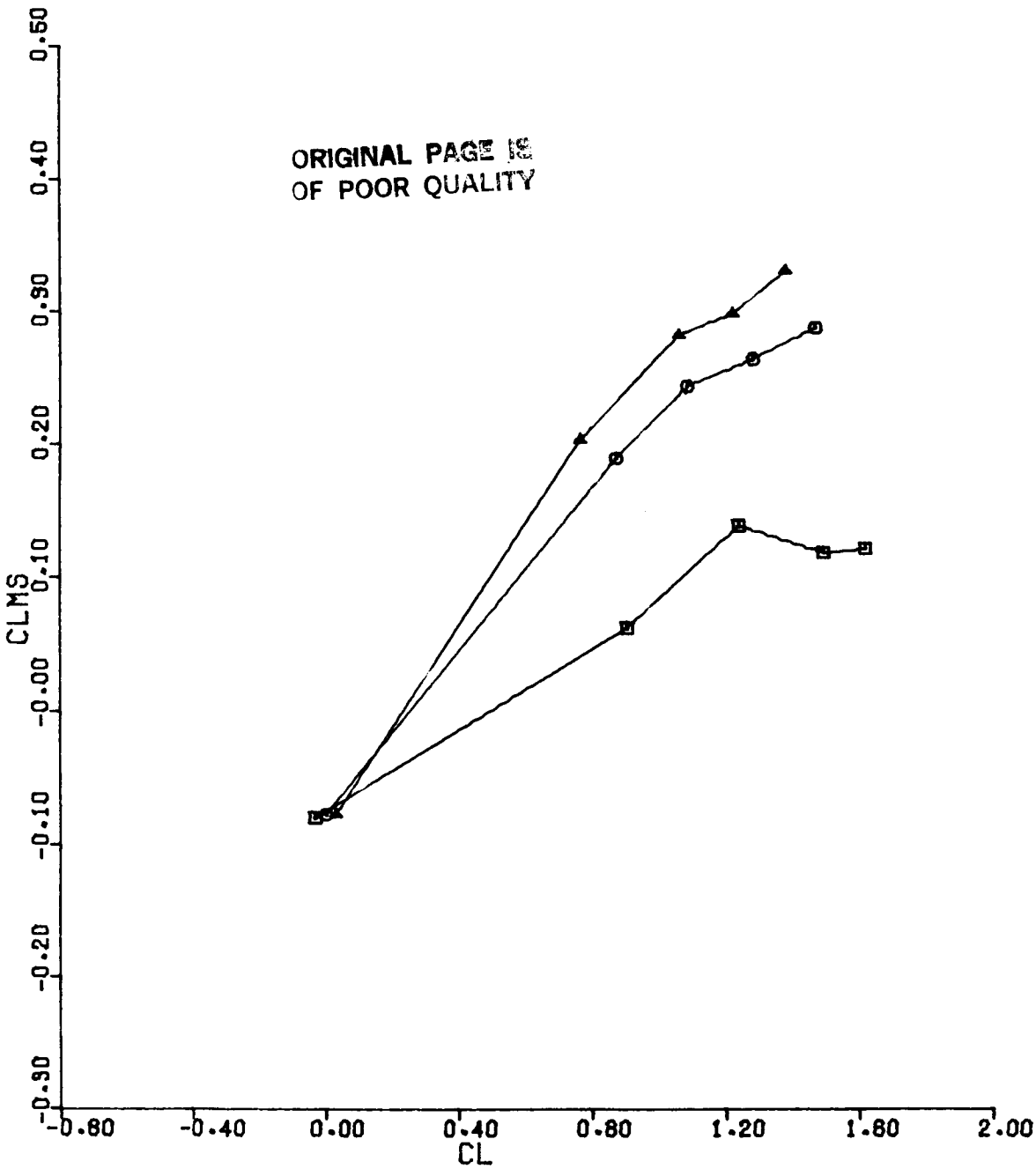

Figure 66(c). CLMS vs CL
Configuration 6, BETA = 0, DC = 0

SYMBOL	RUN	DC
□	219	10
○	223	0
△	226	-10

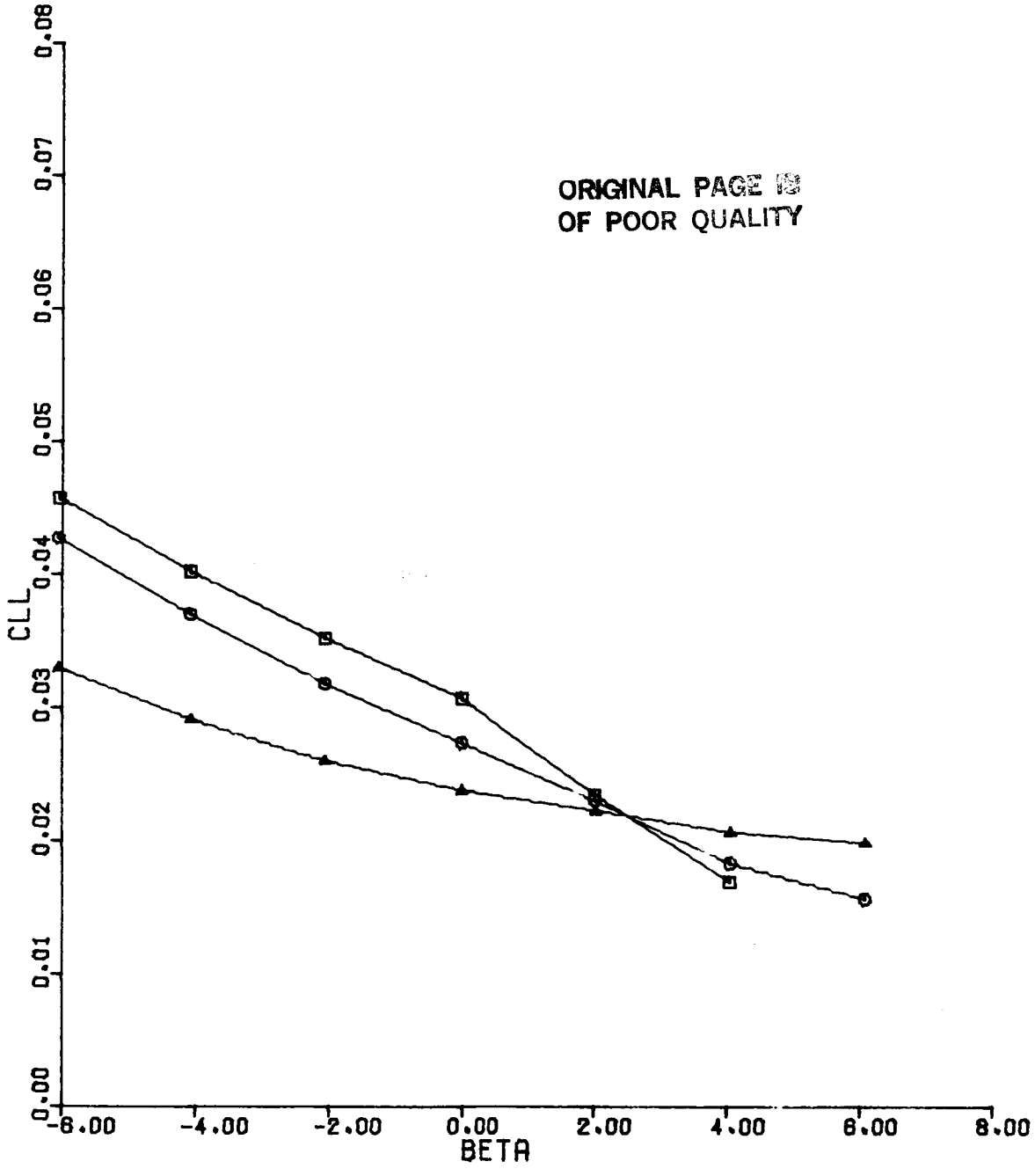

Figure 67(a). CLL vs BETA
Configuration 6, ALPHA = 11, MACH = 0.9

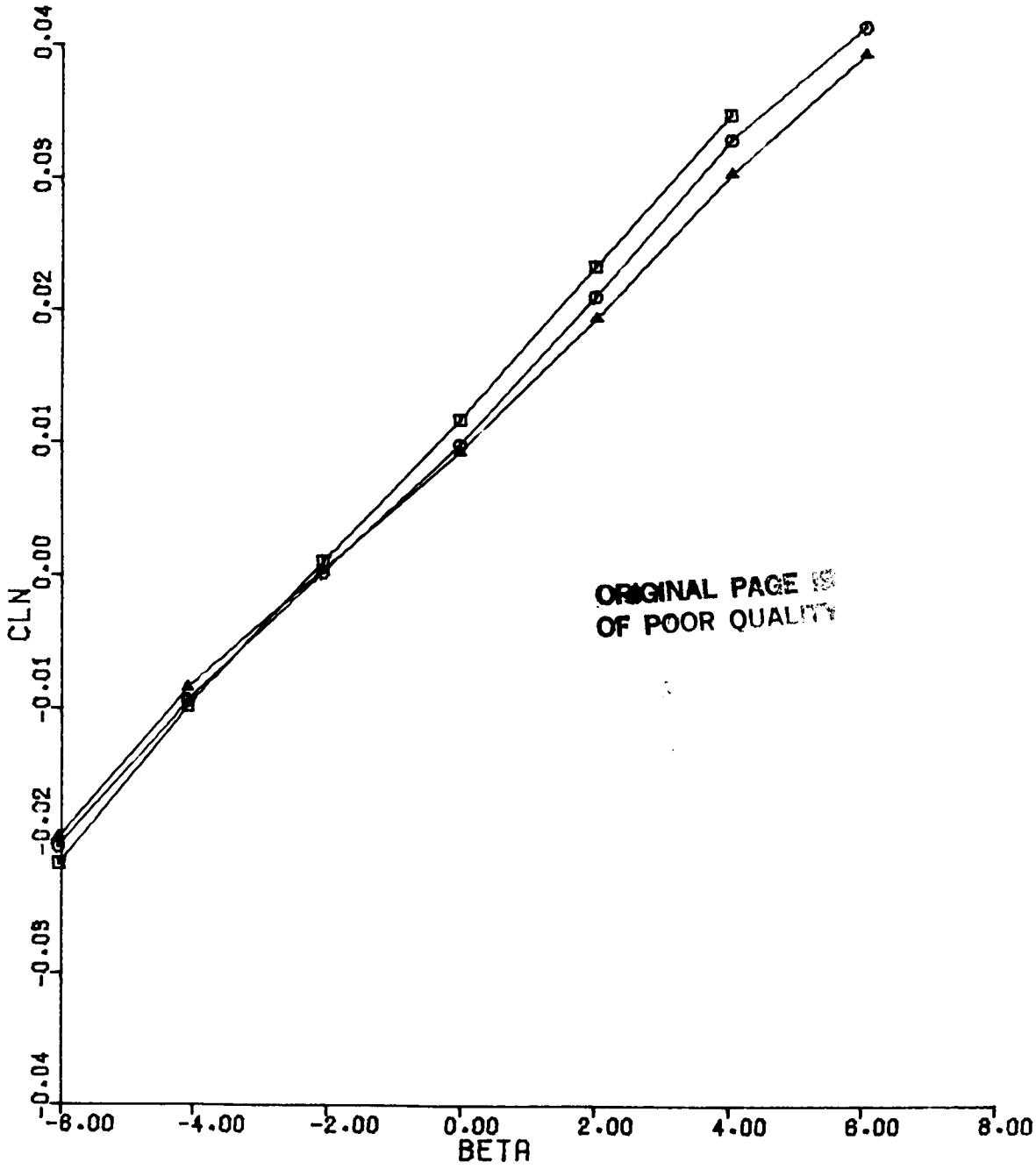

Figure 67(b). CLN vs BETA
Configuration 6, ALPHA = 11, MACH = 0.9

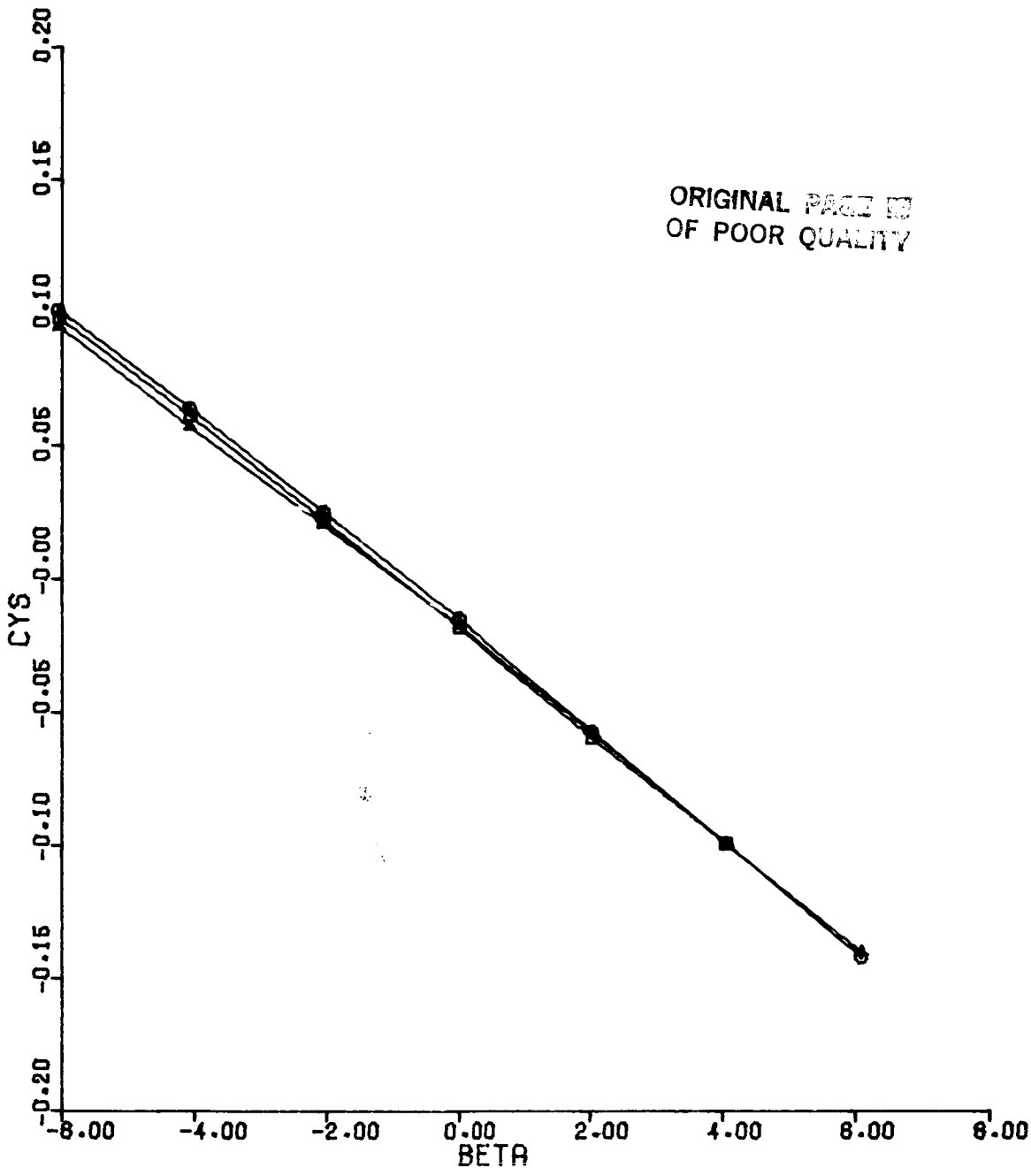

Figure 67(c). CYS vs BETA
Configuration 6, ALPHA = 11, MACH = 0.9

SYMBOL	RUN	DC
□	231	-10
○	234	0
△	237	10

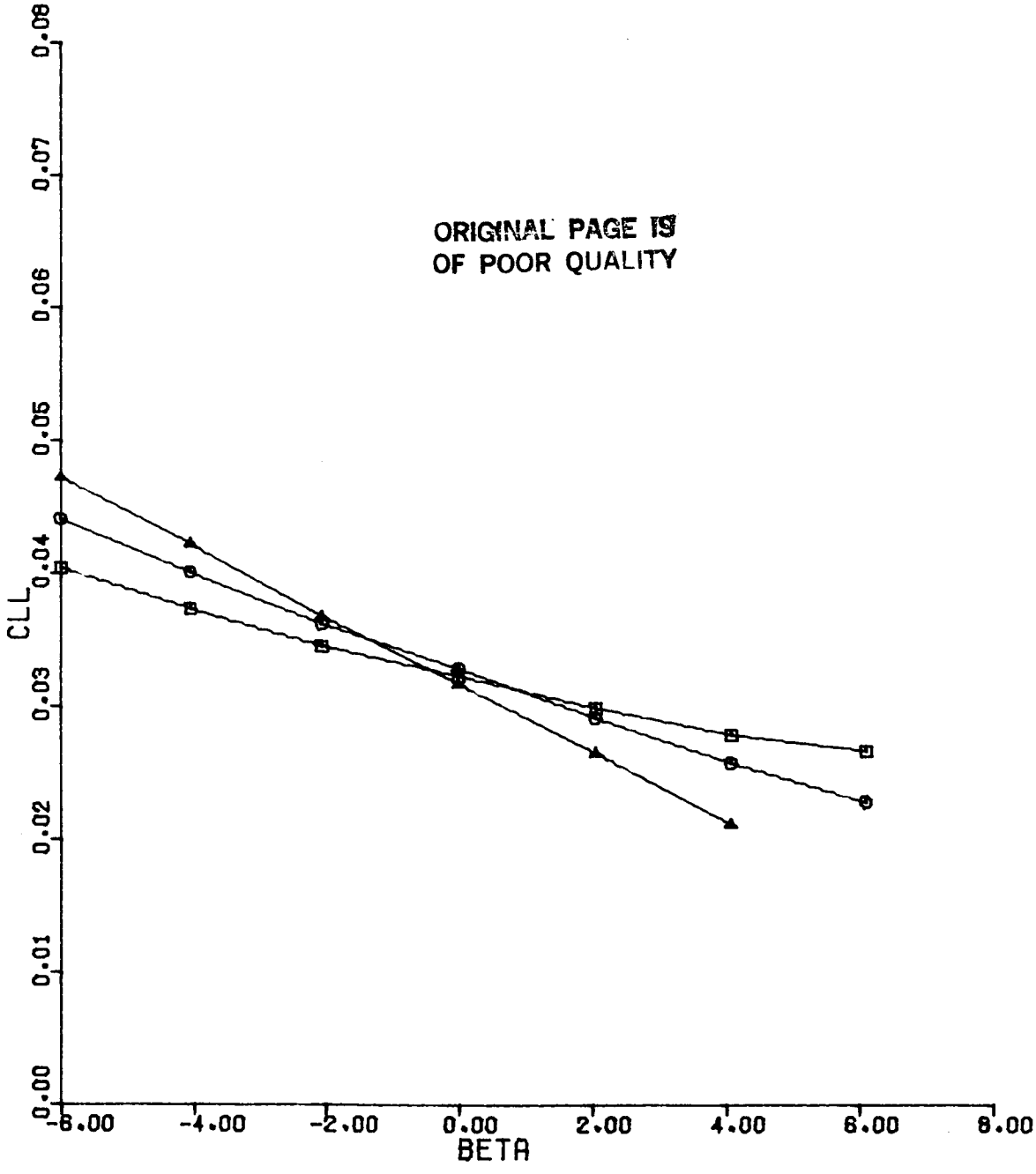

Figure 68(a). CLL vs BETA
Configuration 6, ALPHA = 10, MACH = 0.6

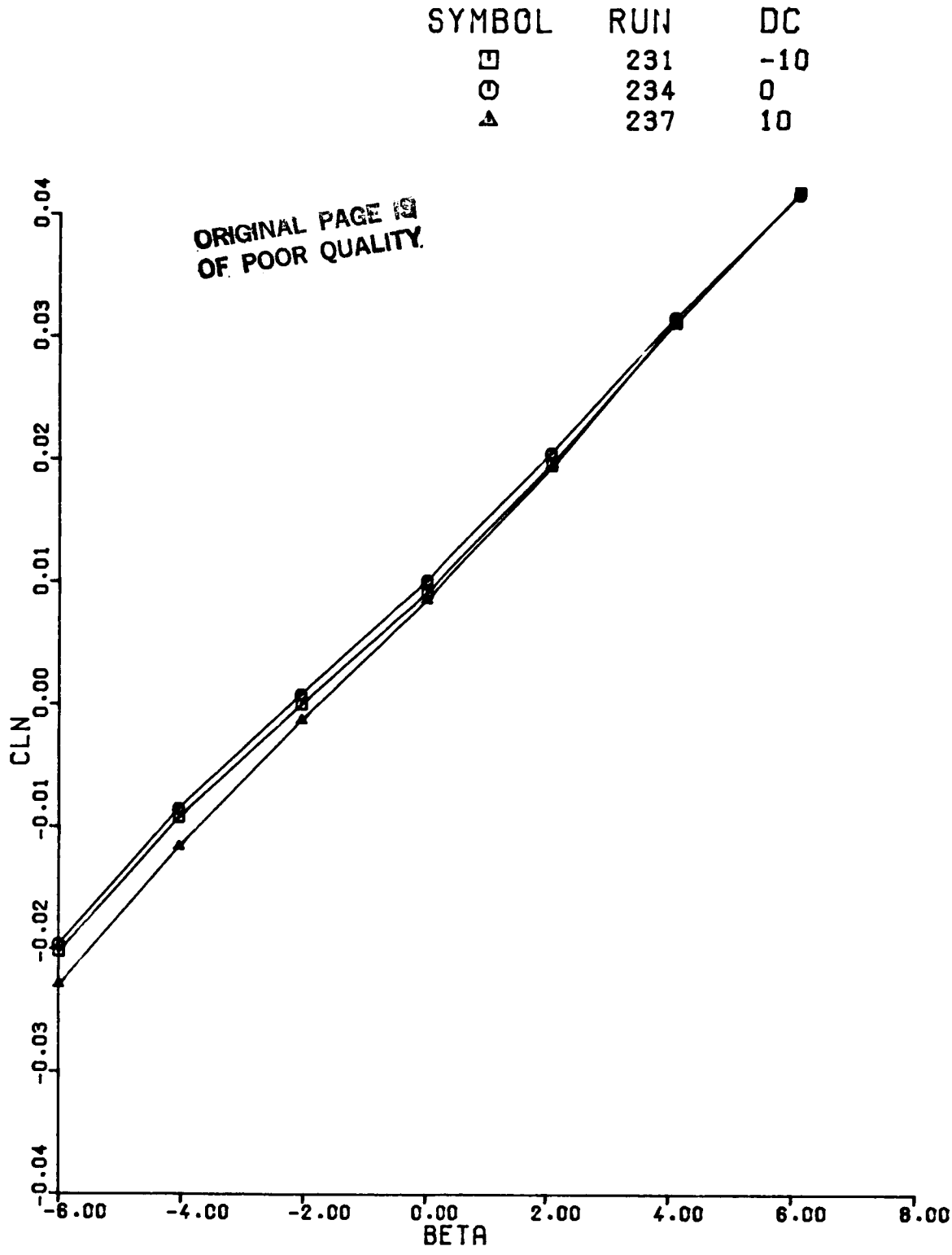

Figure 68(b). CLN vs BETA
Configuration 6, ALPHA = 10, MACH = 0.6

SYMBOL	RUN	DC
□	231	-10
○	234	0
△	237	10

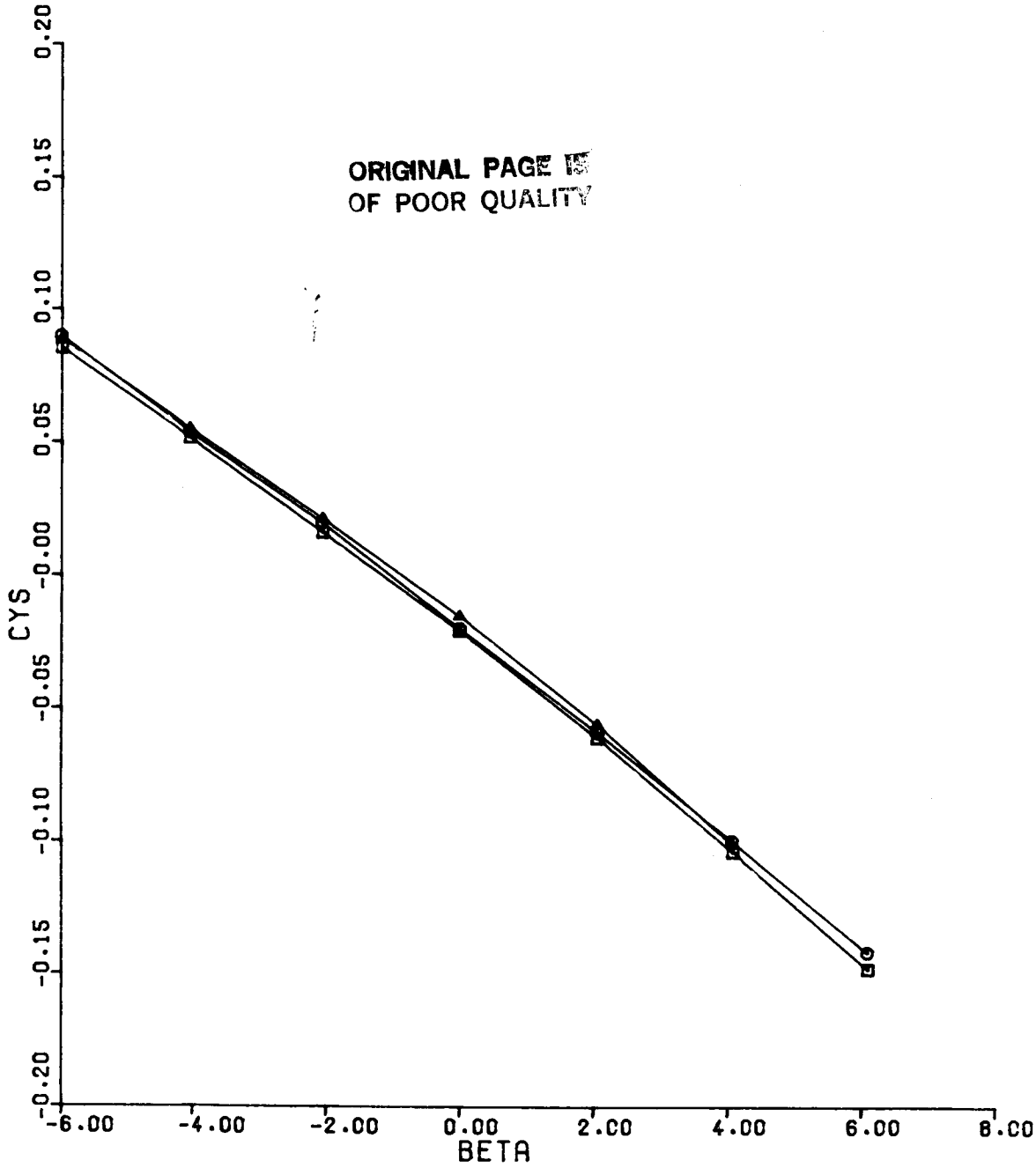

Figure 68(c). CYS vs BETA
Configuration 6, ALPHA = 10, MACH = 0.6

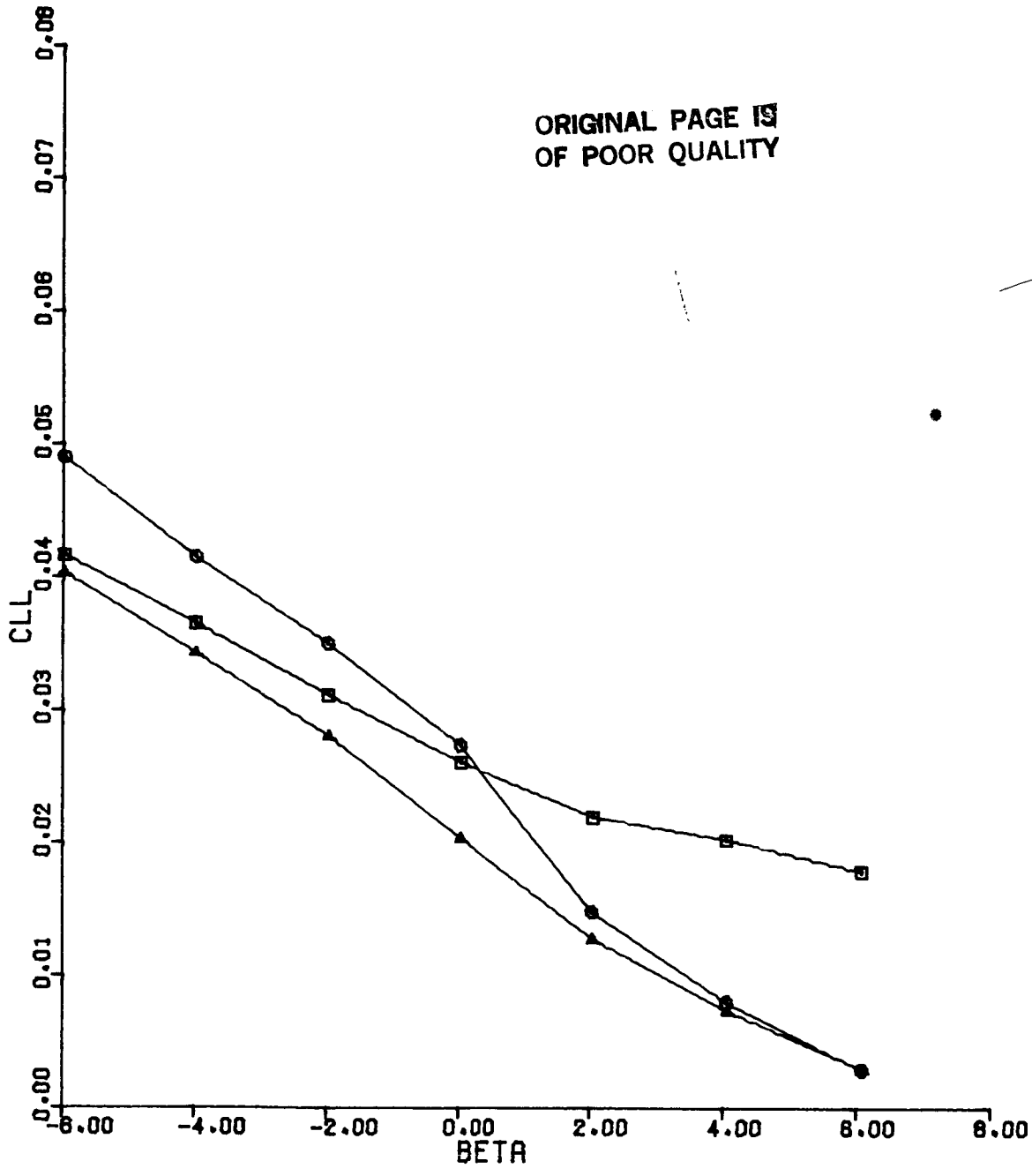

Figure 69(a). CLL vs BETA
Configuration 6, ALPHA = 16, MACH = 0.9

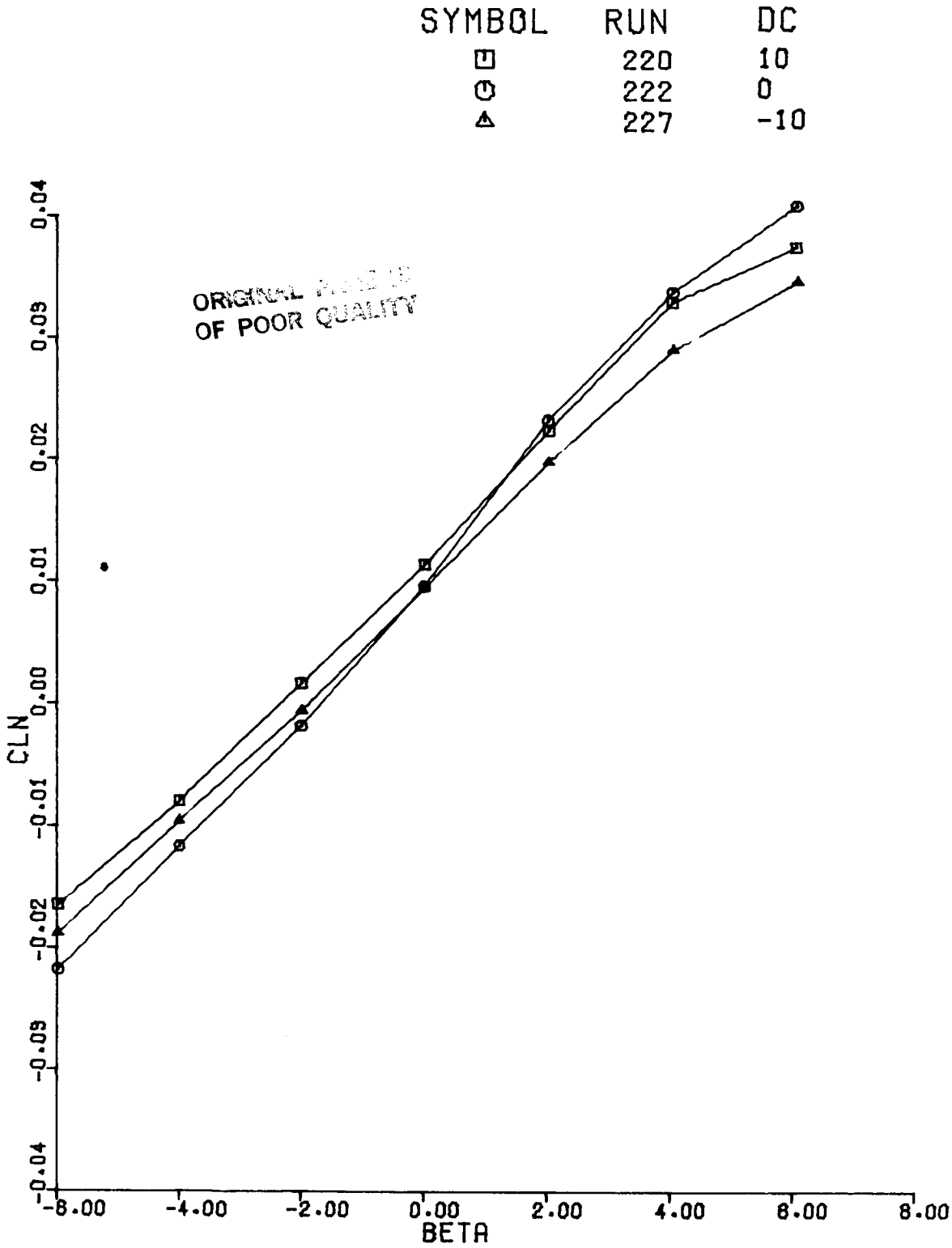

Figure 69(b). CLN vs BETA
Configuration 6, ALPHA = 16, MACH = 0.9

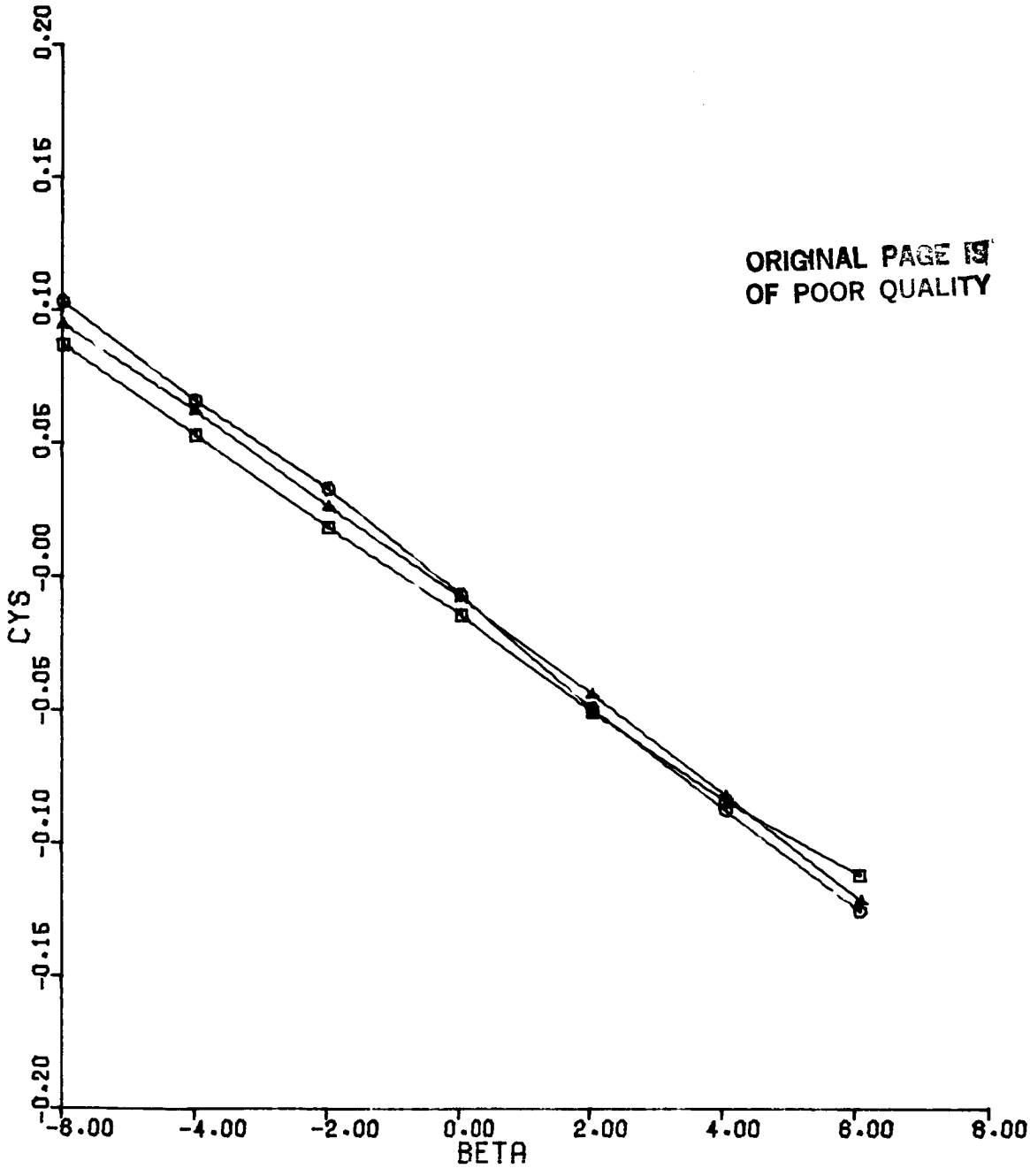

Figure 69(c). CYS vs BETA
Configuration 6, ALPHA = 16, MACH = 0.9

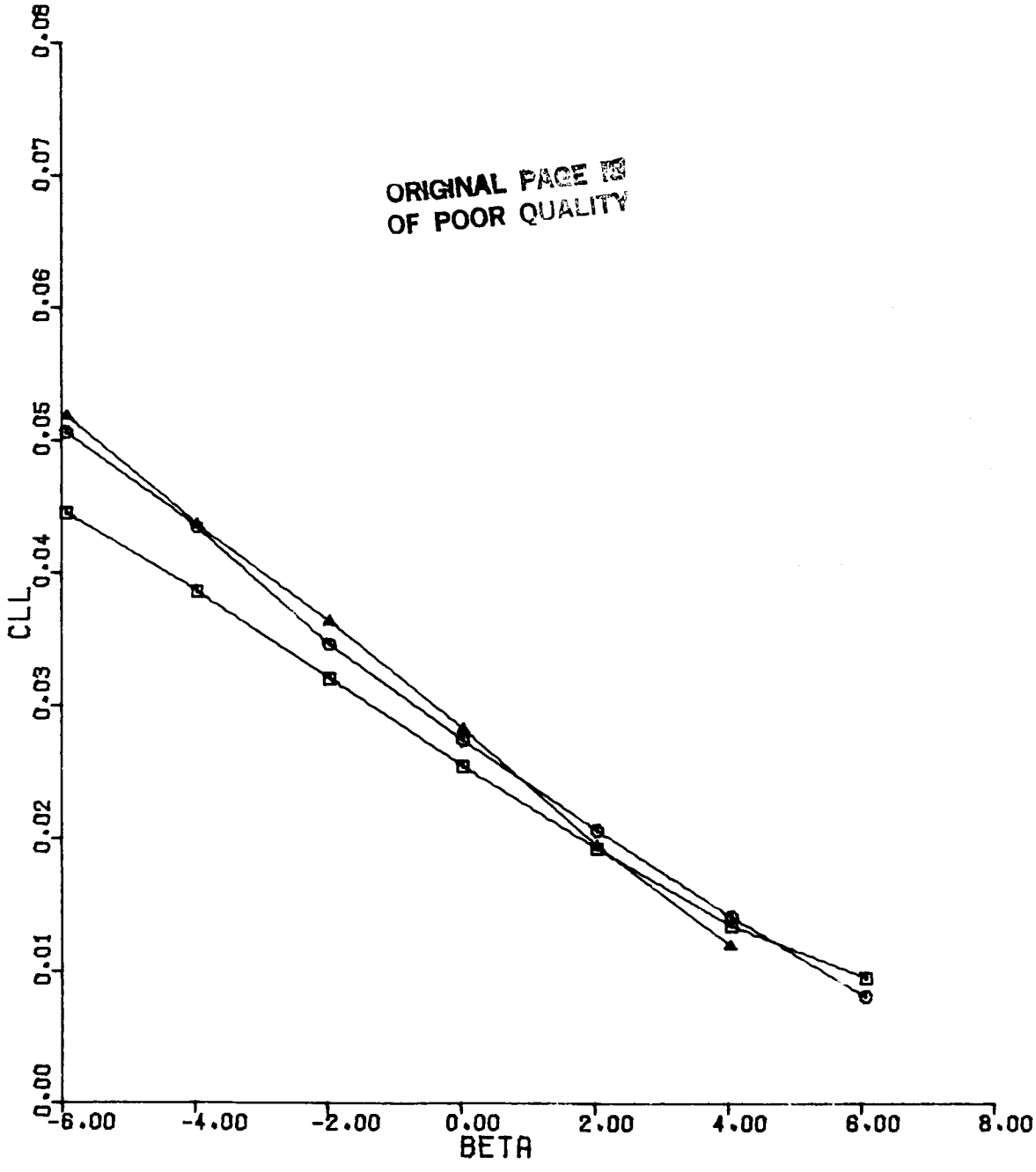

Figure 70(a). CLL vs BETA
Configuration 6, ALPHA = 15, MACH = 0.6

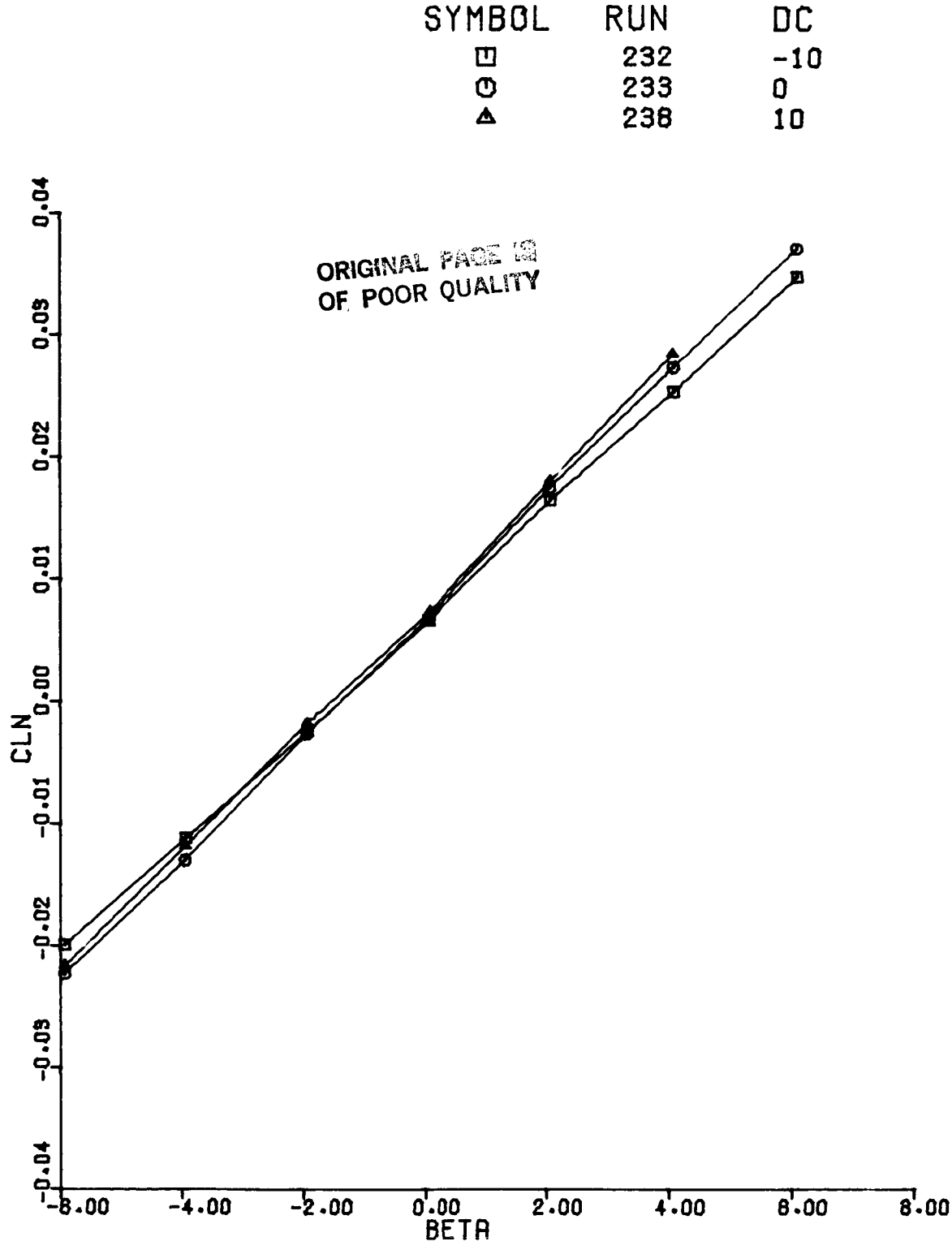

Figure 70(b). CLN vs BETA
Configuration 6, ALPHA = 15, MACH = 0.6

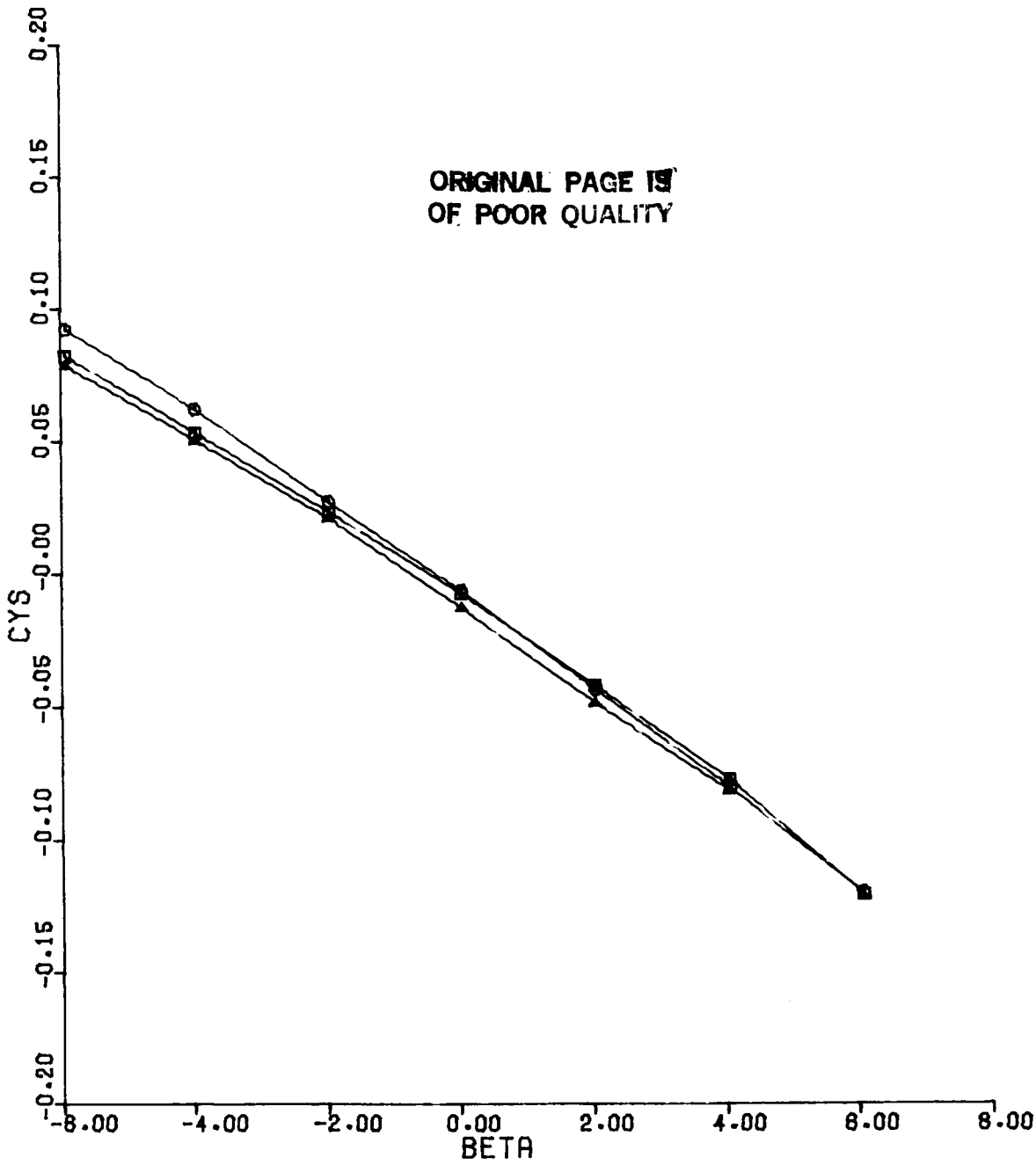

Figure 70(c). CYS vs BETA
Configuration 6, ALPHA = 15, MACH = 0.6

SYMBOL	RUN	DC
□	241	15
○	242	10
△	243	0
+	244	-10
×	245	-20

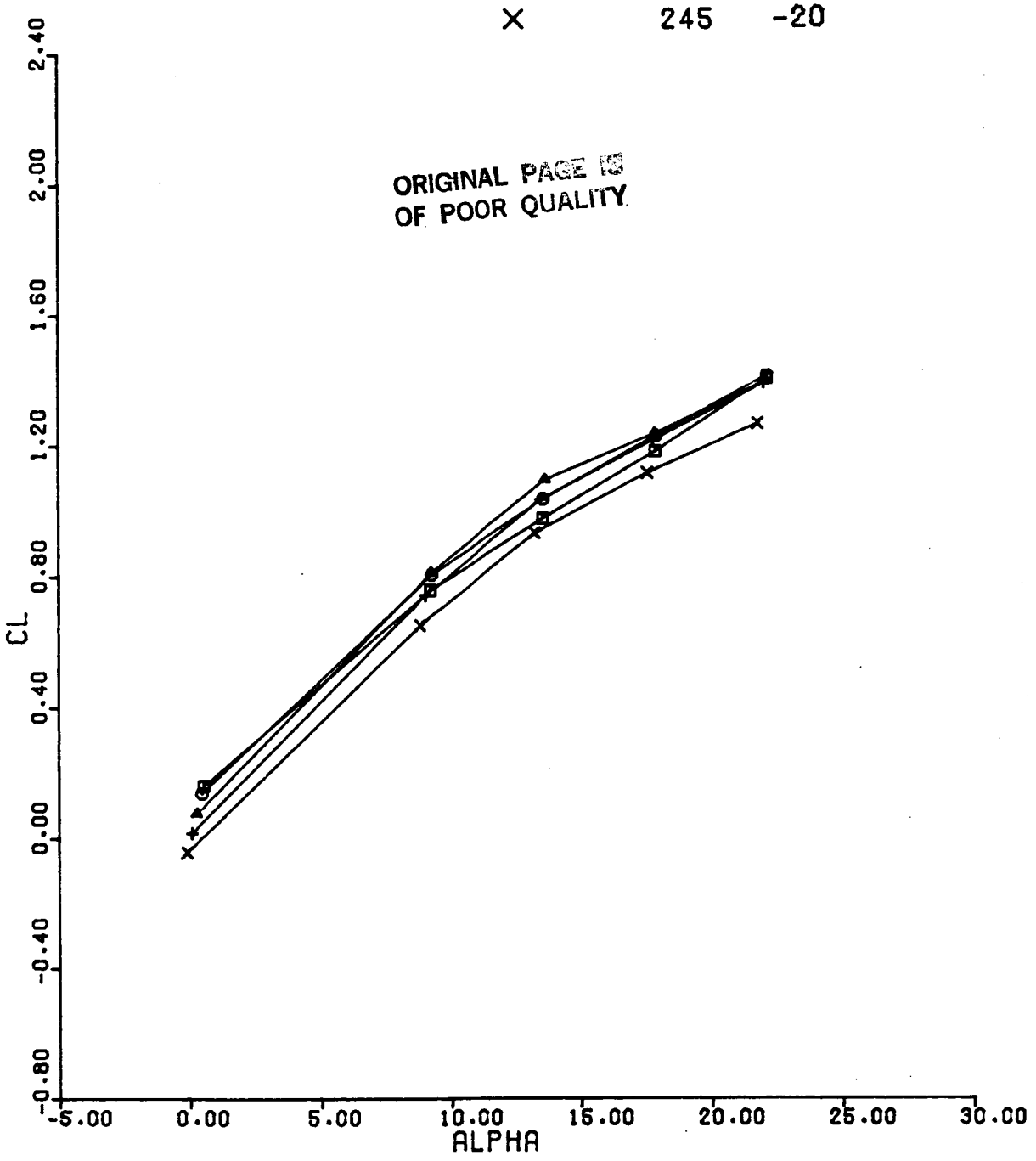

Figure 71(a). CL vs ALPHA
Configuration 7, BETA = 0, MACH = 0.6

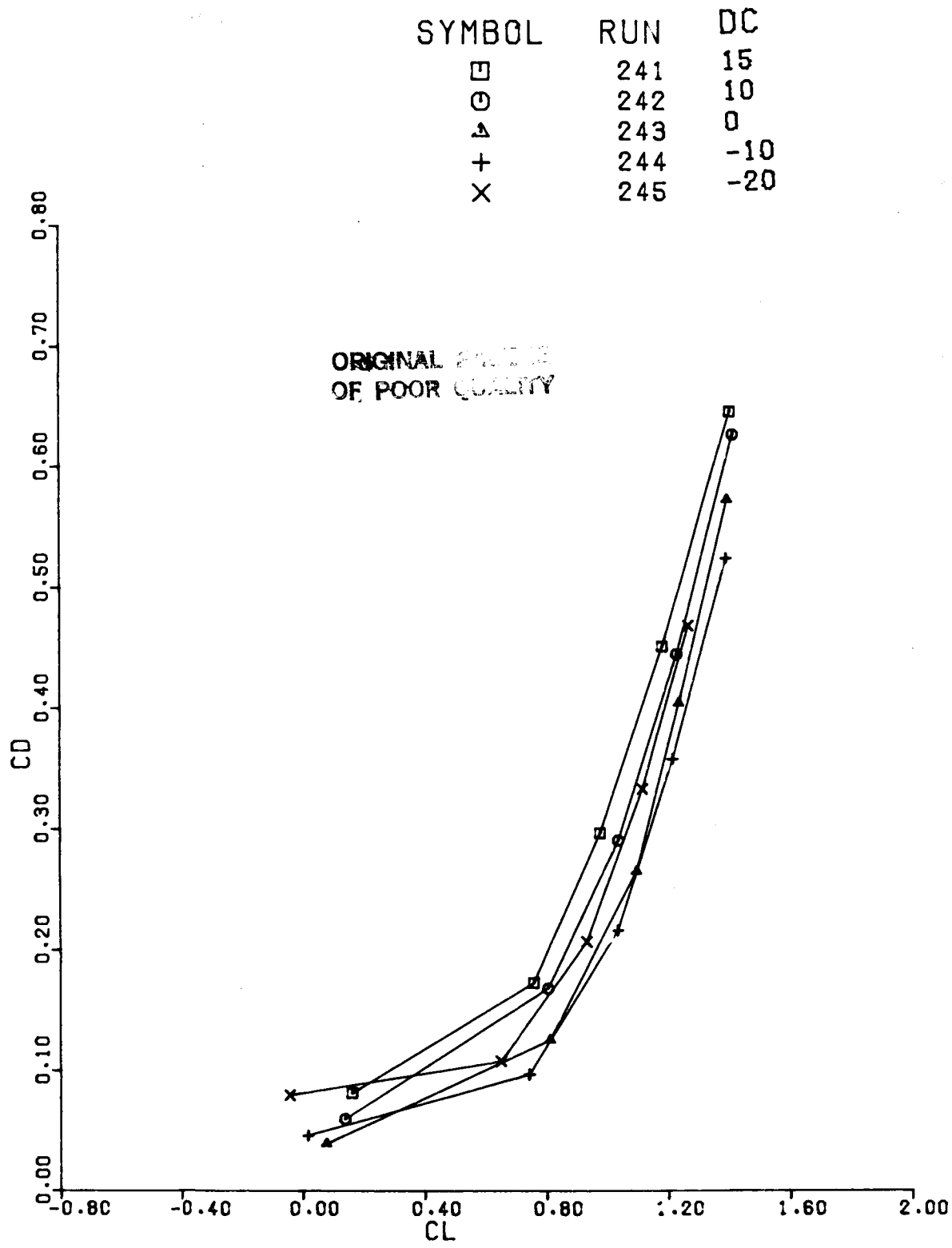

Figure 71(b). CD vs CL
Configuration 7, BETA = 0, MACH = 0.6

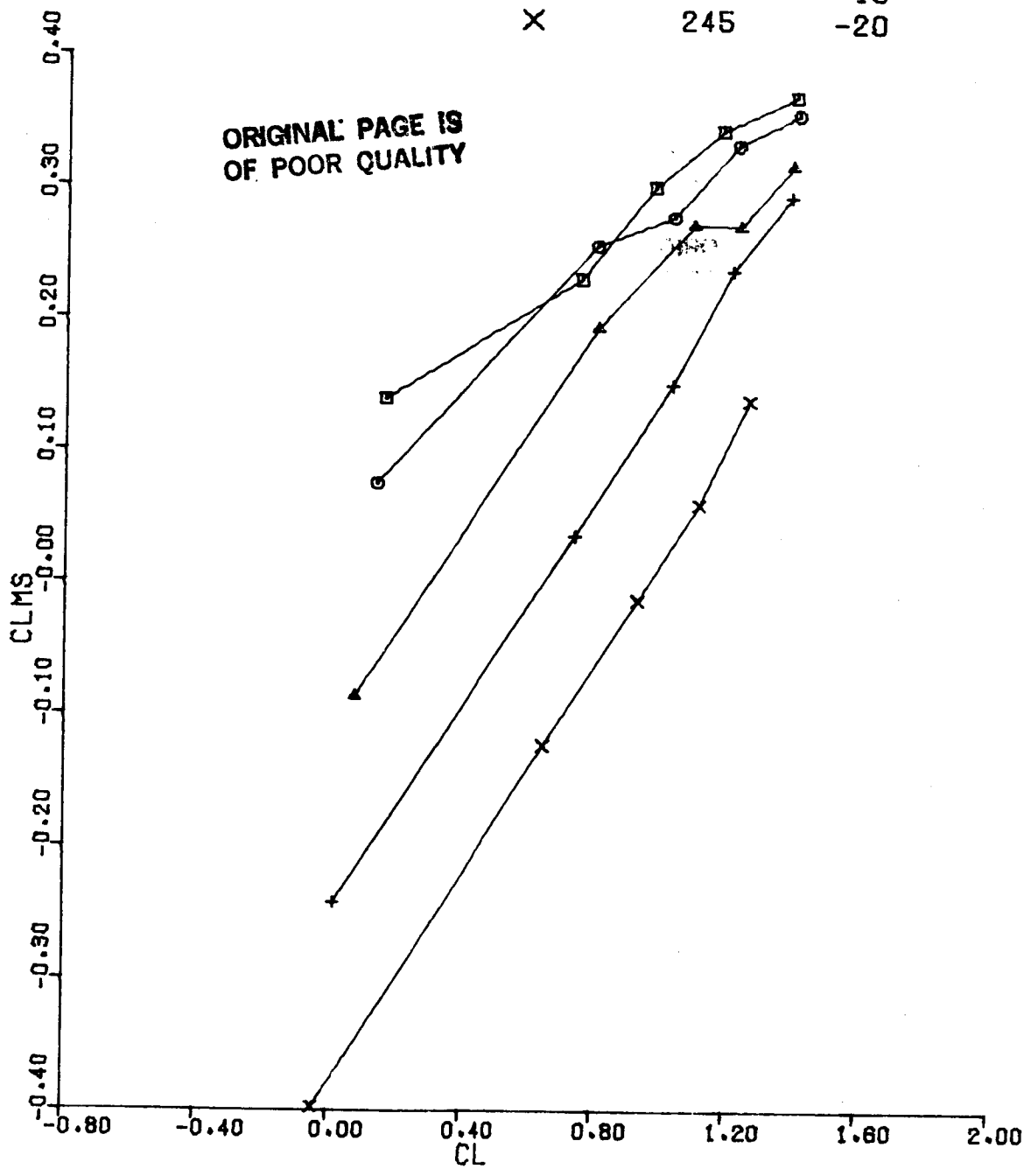

Figure 71(c). CLMS vs CL
Configuration 7, BETA = 0, MACH = 0.6

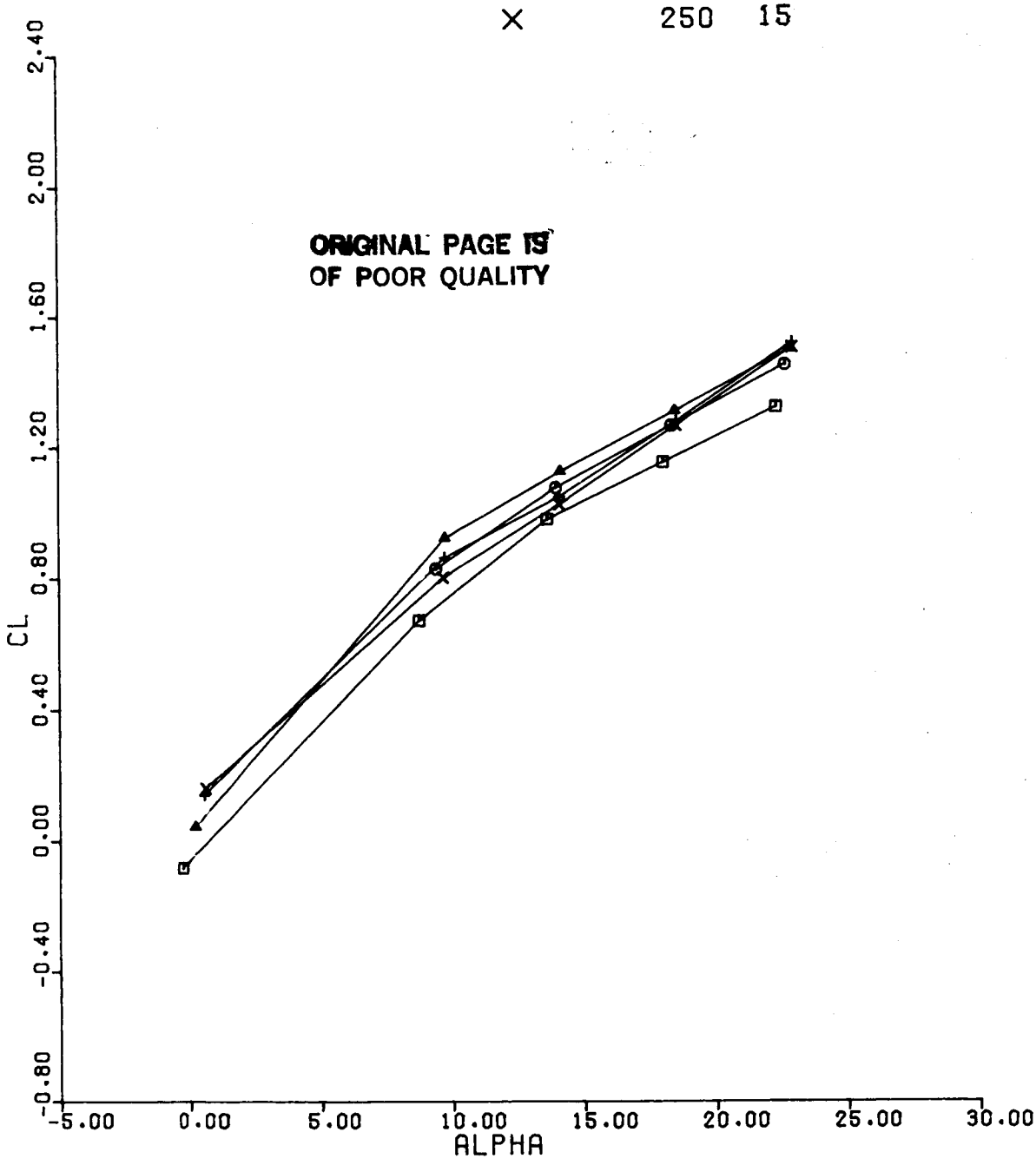

Figure 72(a). CL vs ALPHA
Configuration 7, BETA = 0, MACH = 0.9

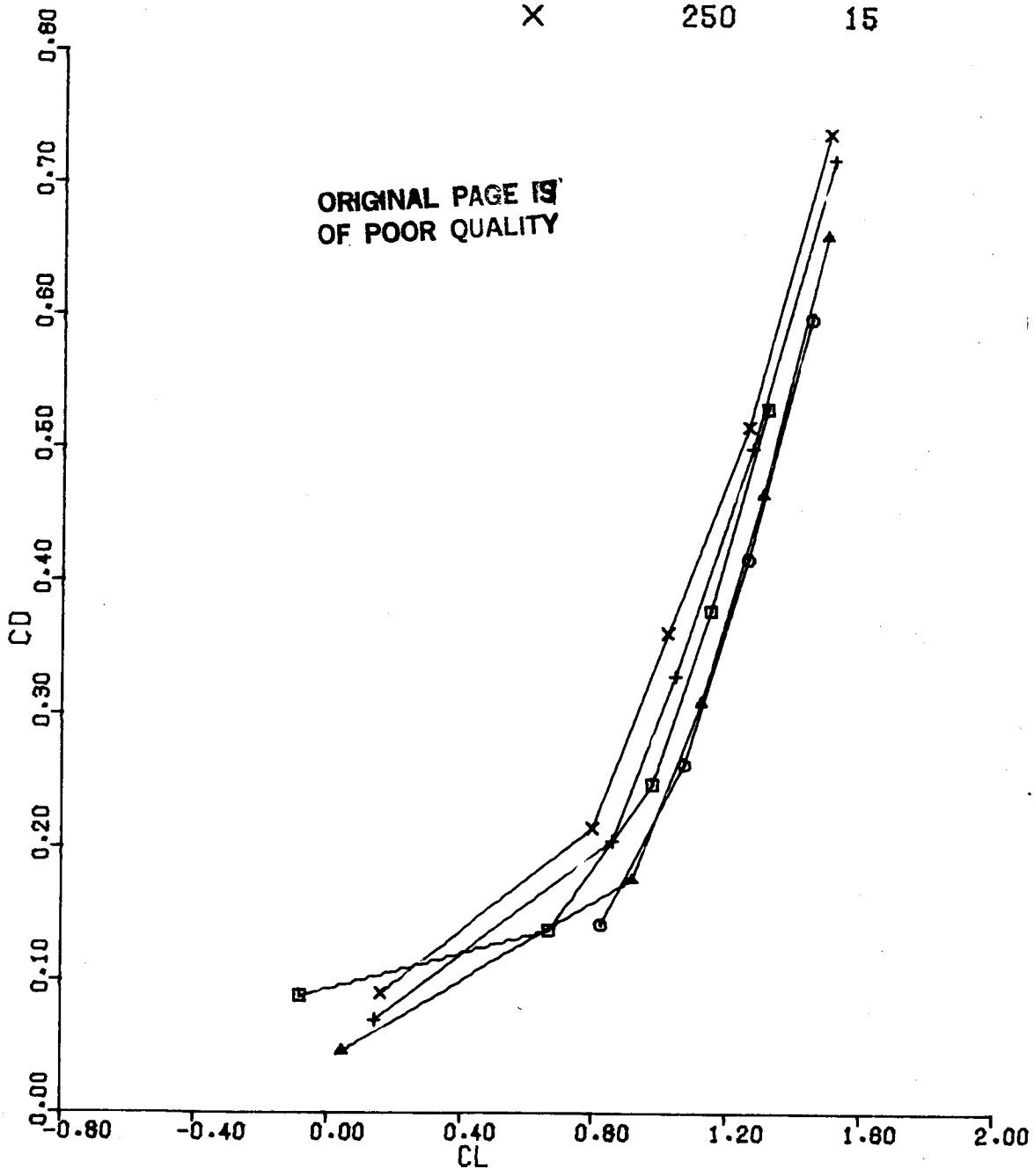

Figure 72(b). CD vs CL
Configuration 7, BETA = 0, MACH = 0.9

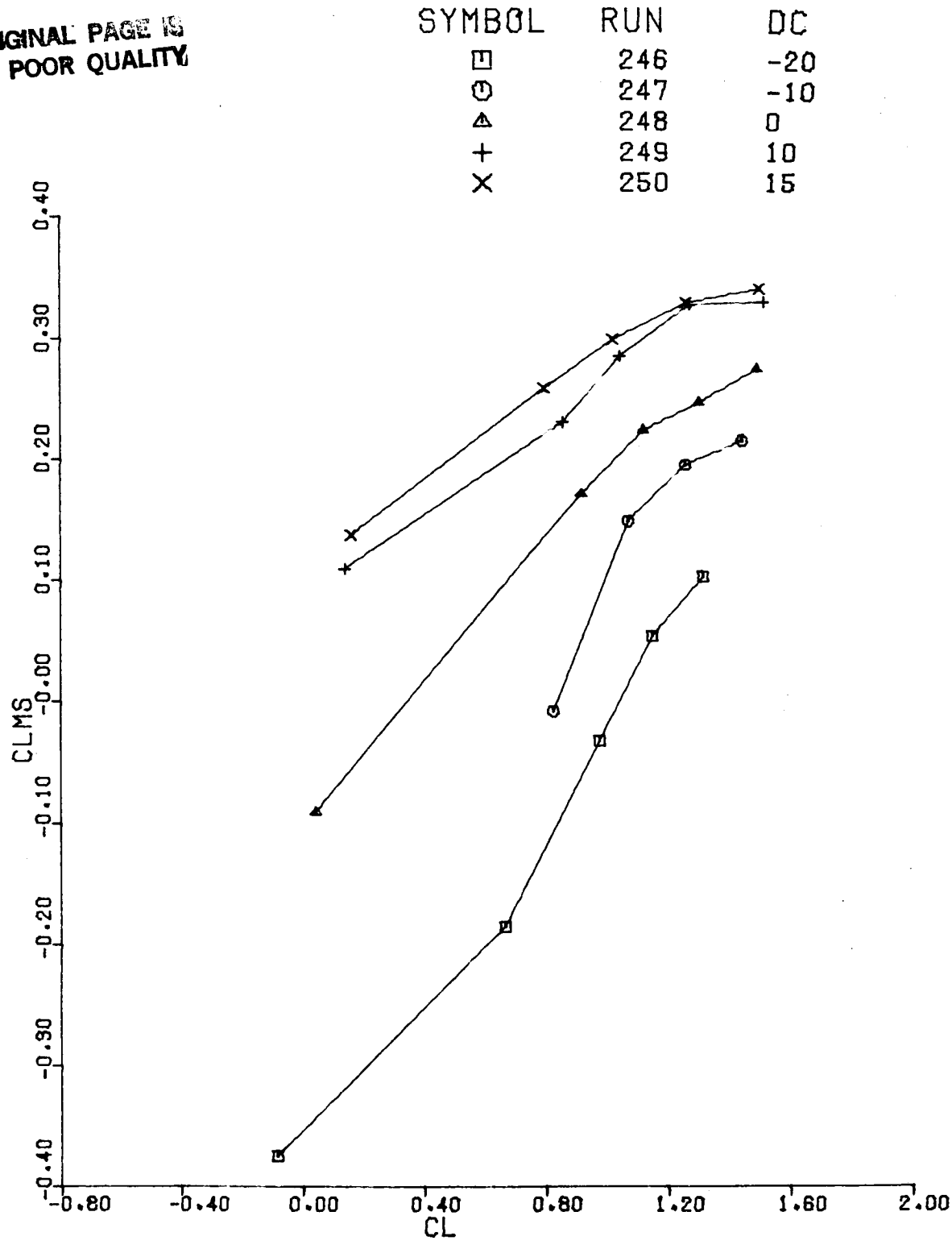

Figure 72(c). CLMS vs CL
Configuration 7, BETA = 0, MACH = 0.9

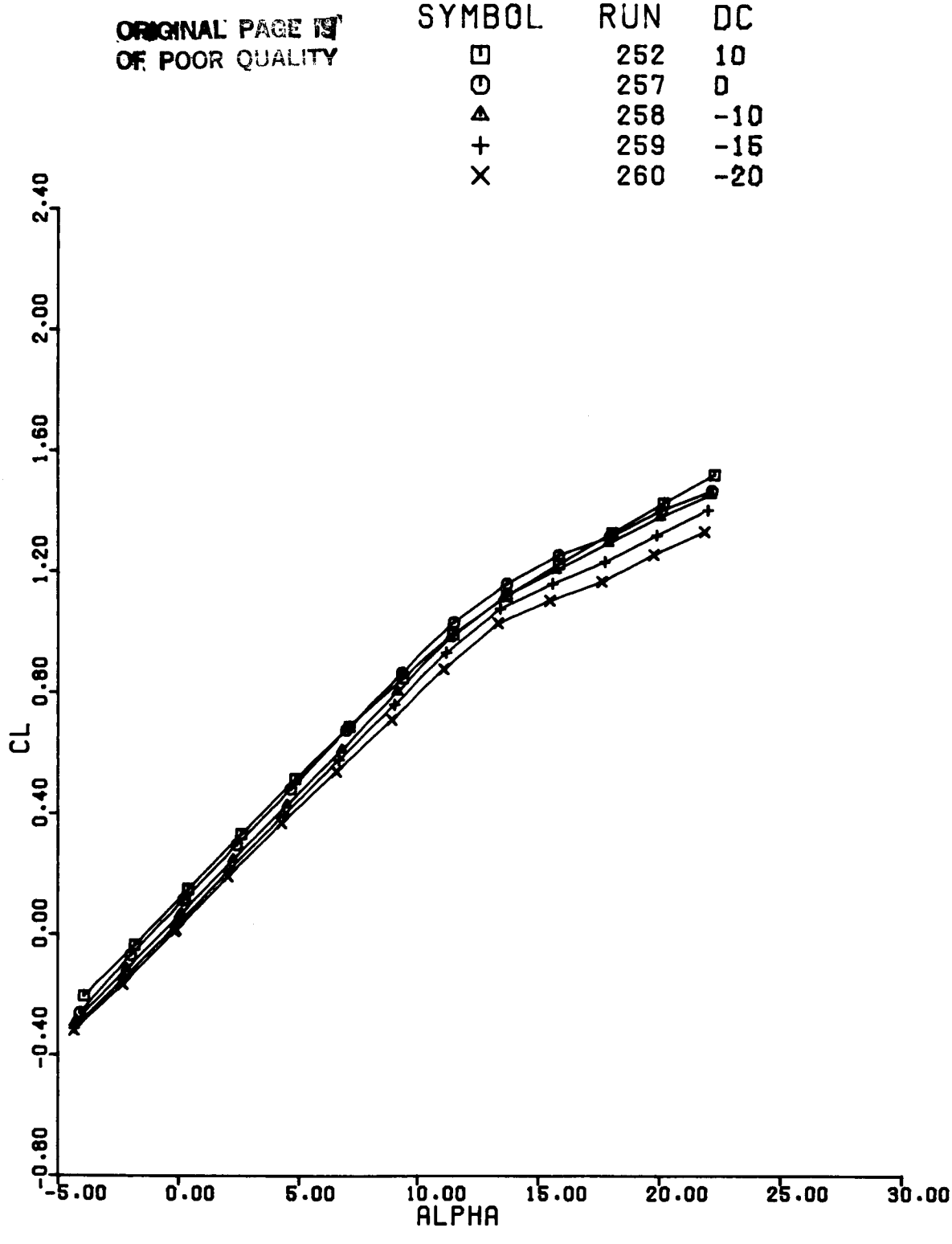

Figure 73(a). CL vs ALPHA
Configuration 8, BETA = 0, MACH = 0.6

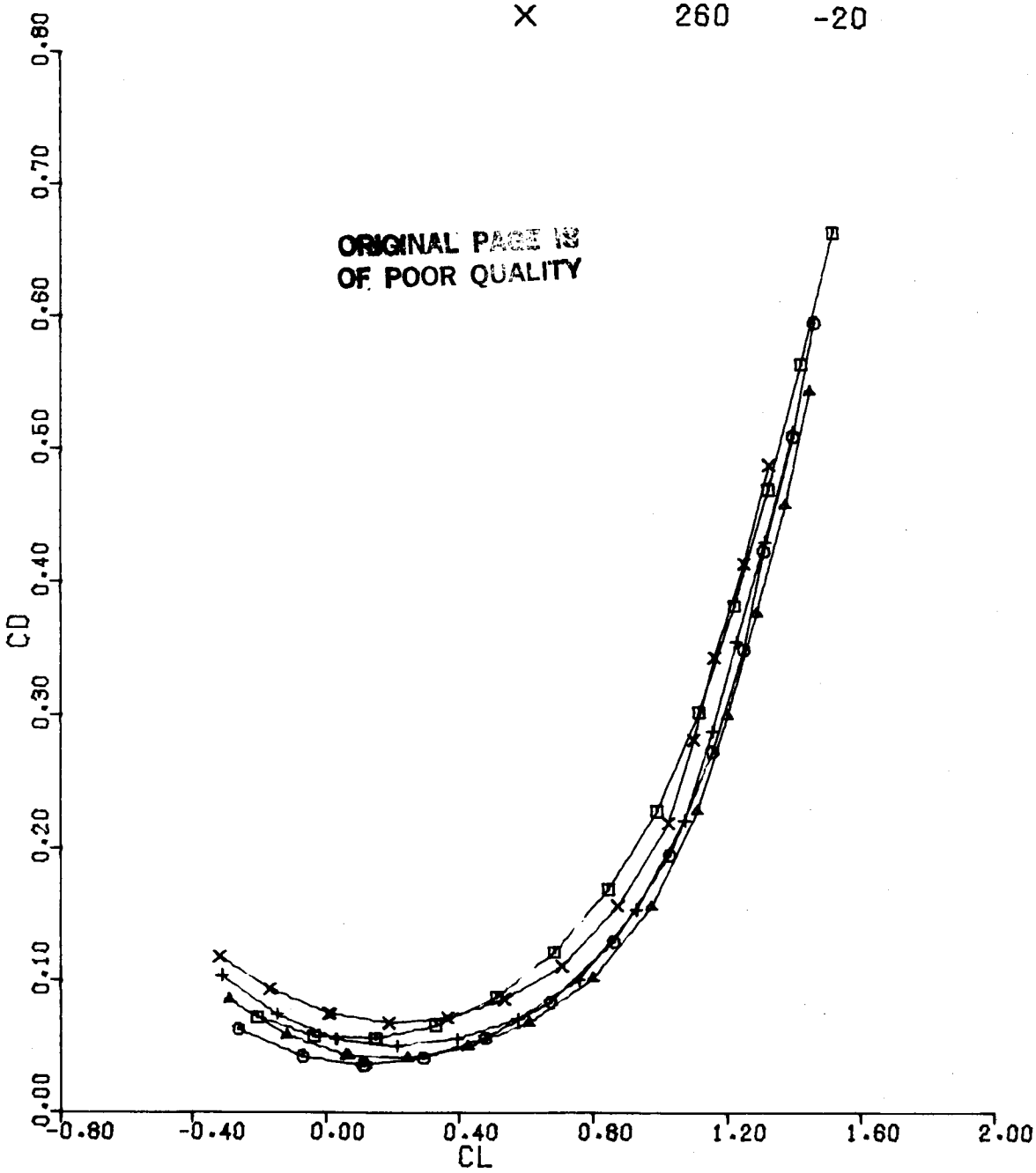

Figure 73(b). CD vs CL
Configuration 8, BETA = 0, MACH = 0.6

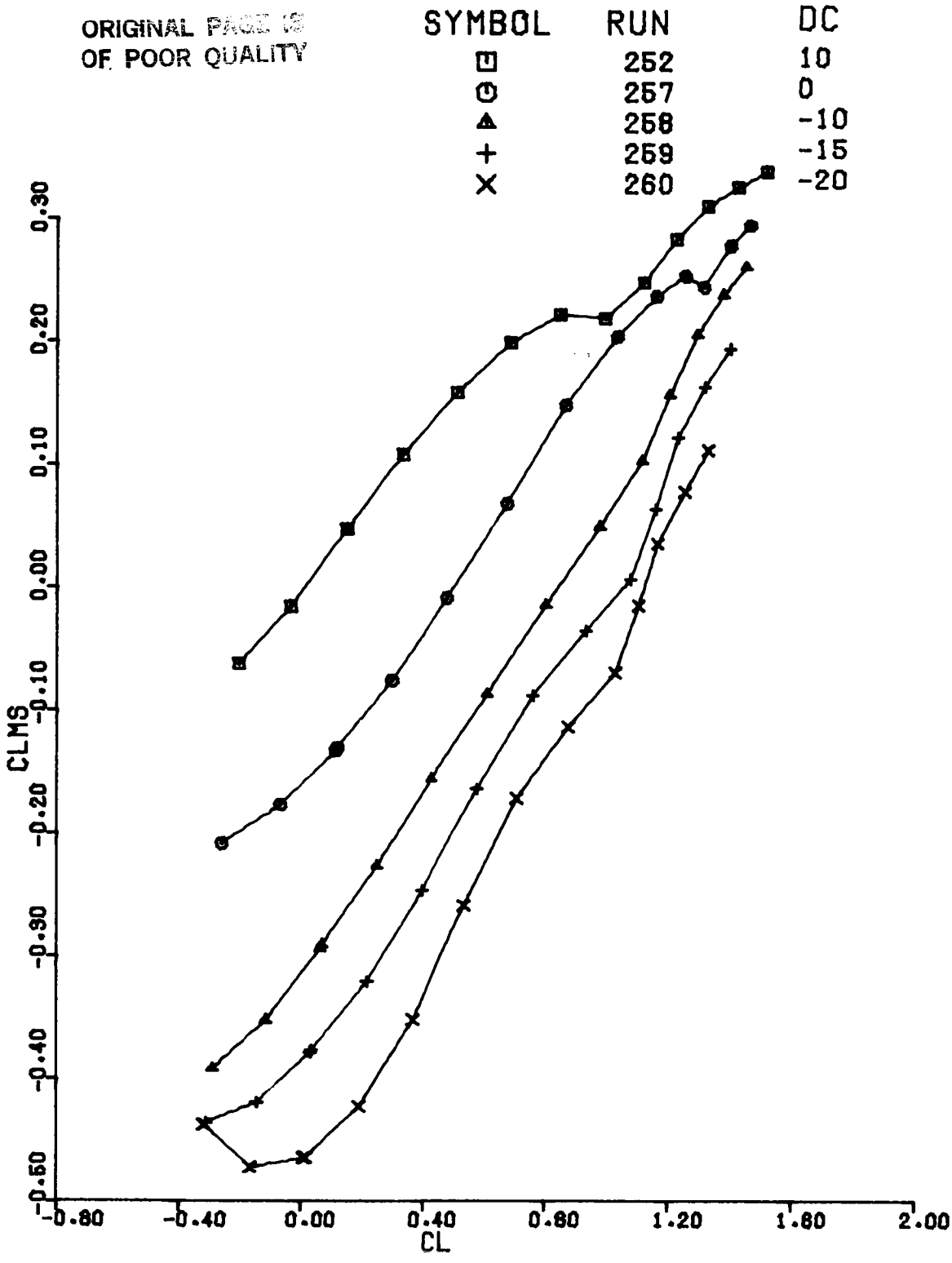

Figure 73(c). CLMS vs CL
Configuration 8, BETA = 0, MACH = 0.6

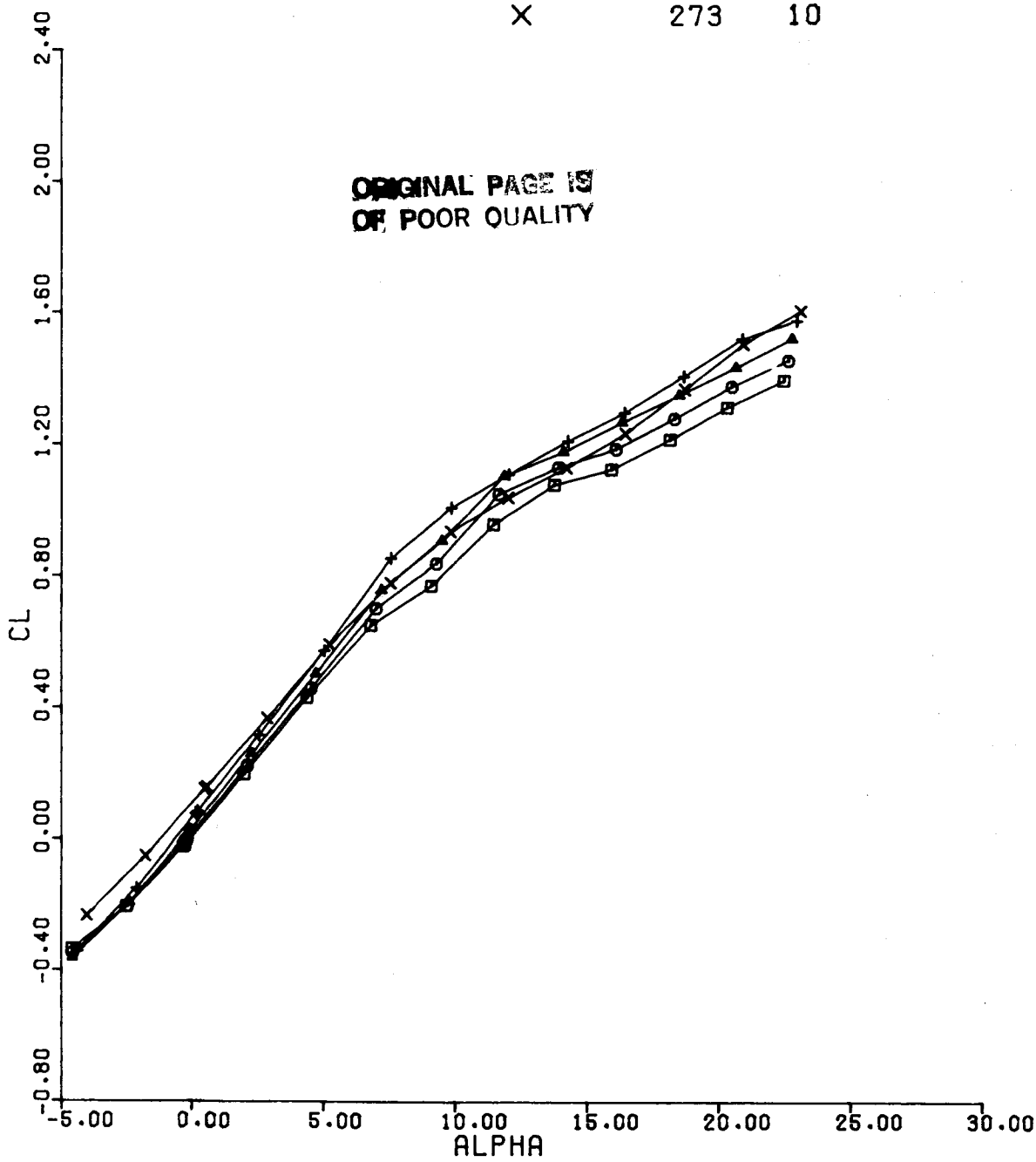

Figure 74(a). CL vs ALPHA
Configuration 8, BETA = 0, MACH = 0.9

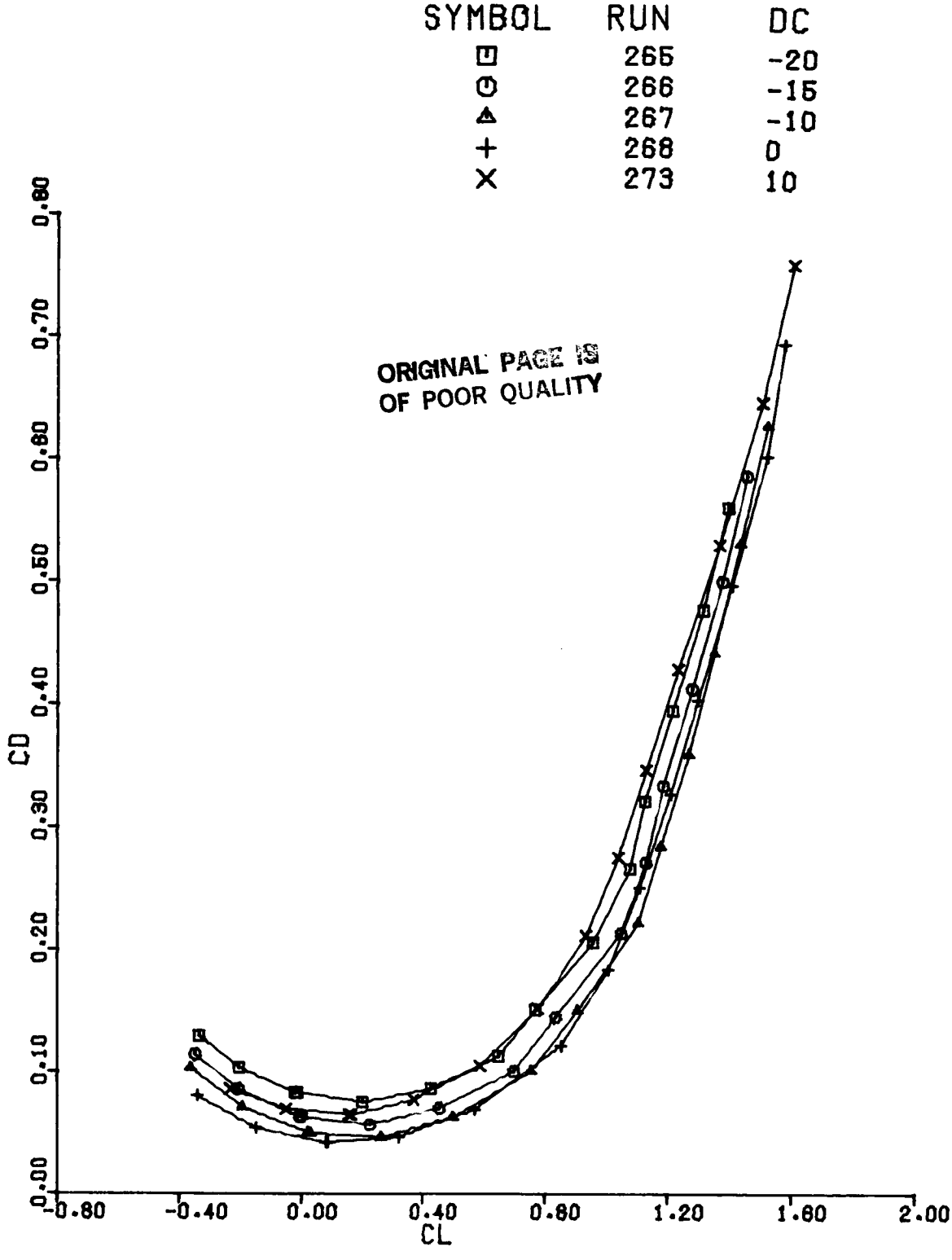

Figure 74(b). CD vs CL
Configuration 8, BETA = 0, MACH = 0.9

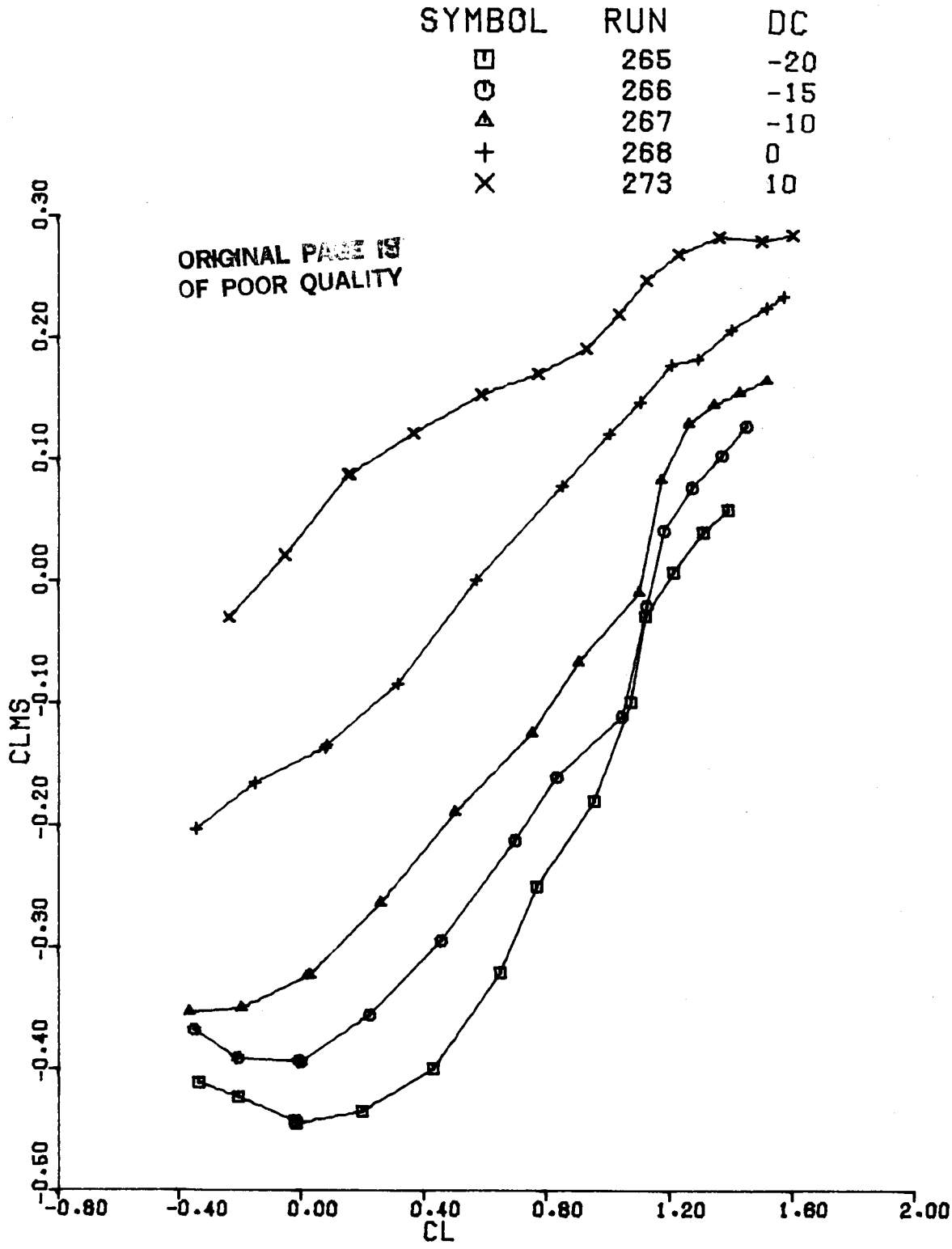

Figure 74(c). CLMS vs CL
Configuration 8, BETA = 0, MACH = 0.9

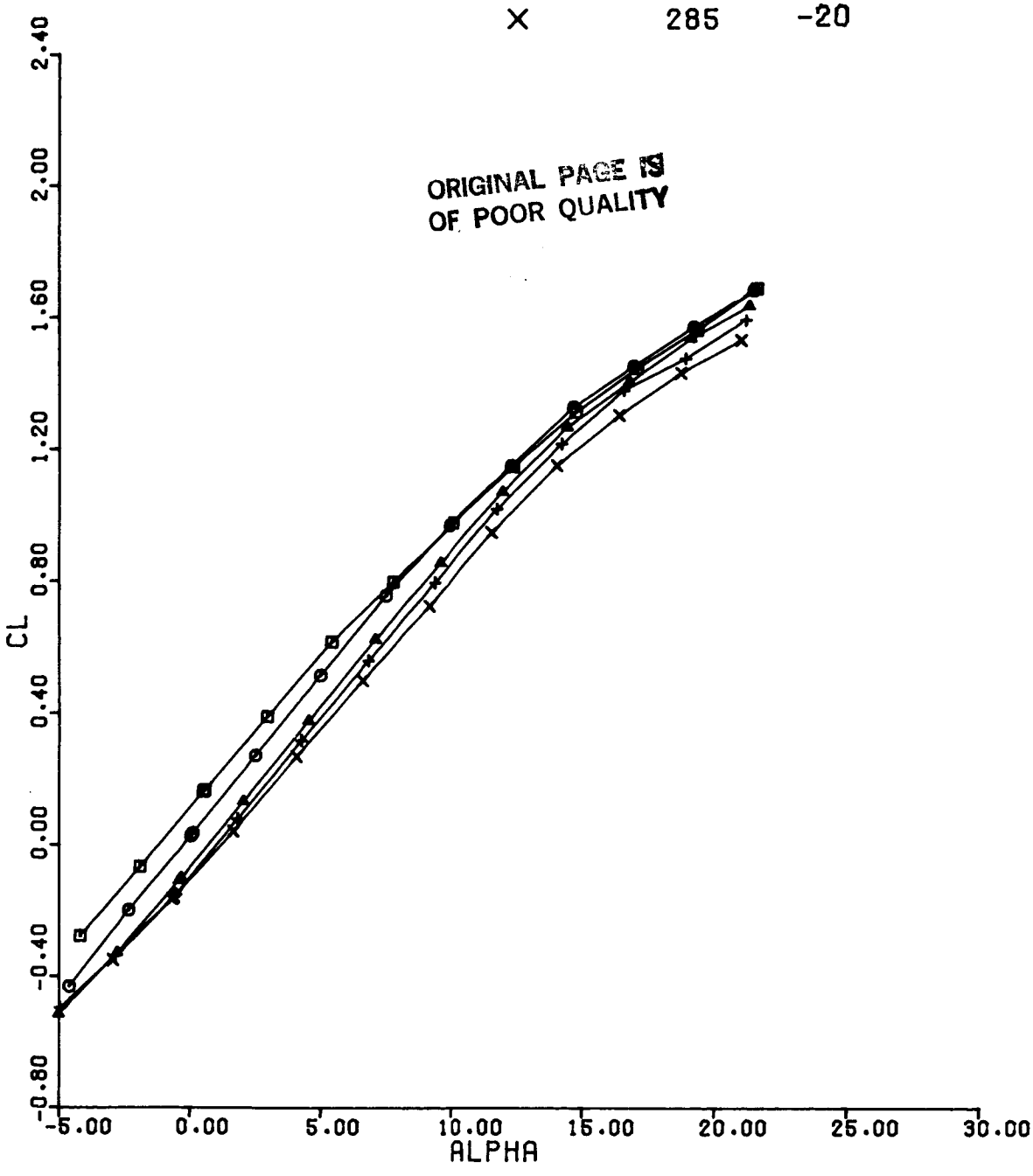

Figure 75(a). CL vs ALPHA
Configuration 8, BETA = 0, MACH = 1.2

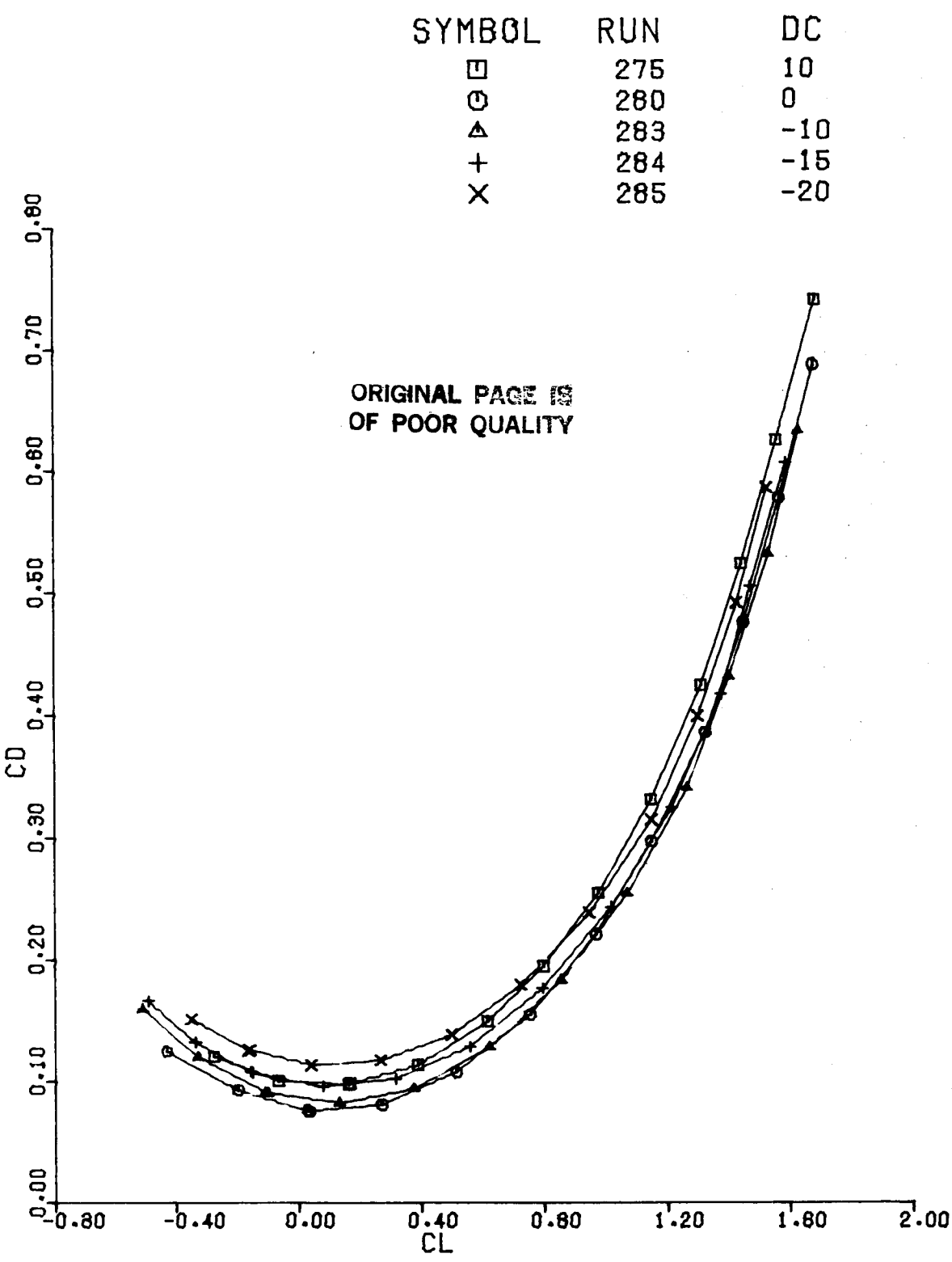

Figure 75(b). CD vs CL
Configuration 8, BETA = 0, MACH = 1.2

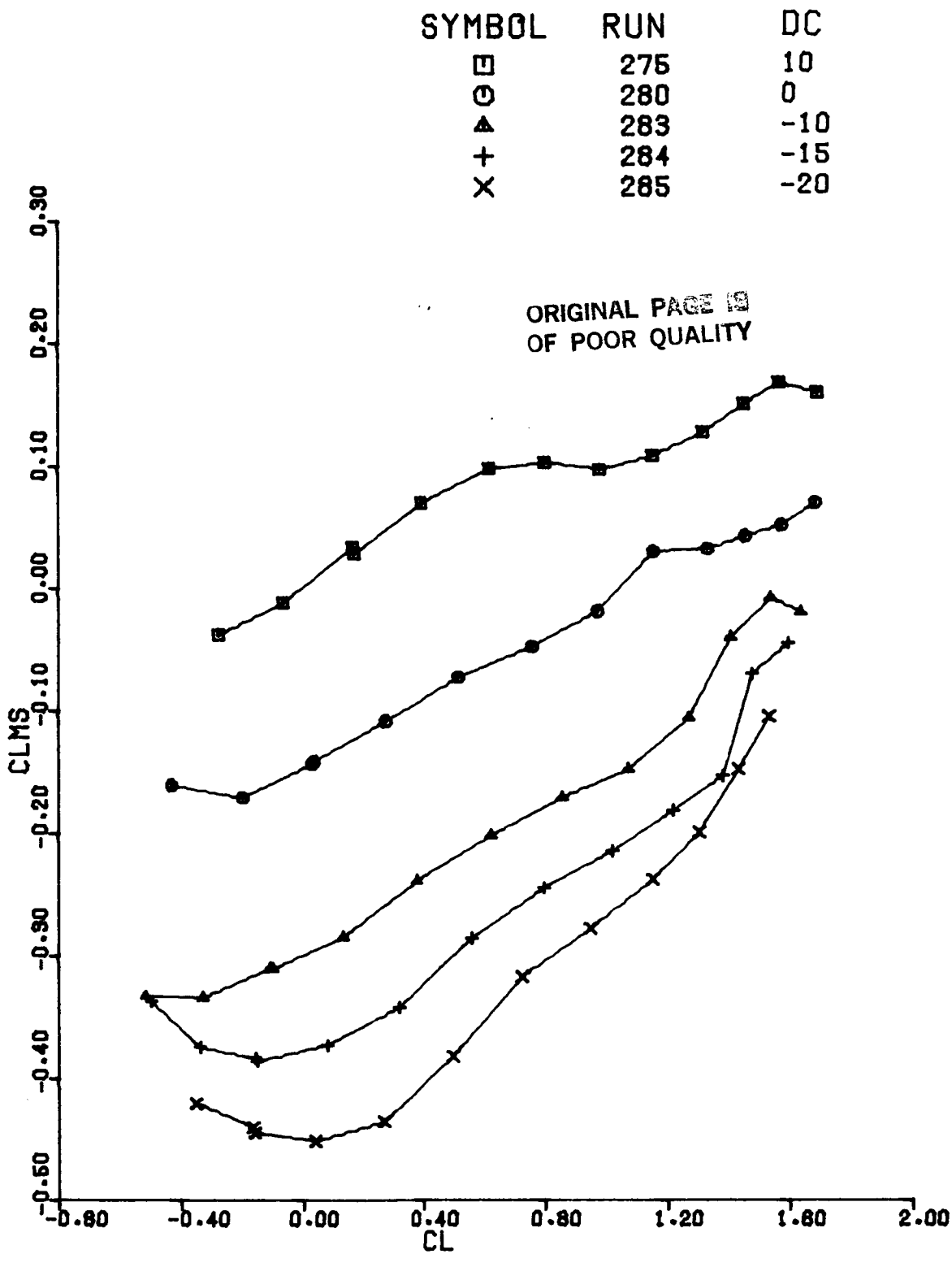

Figure 75(c). CLMS vs CL
Configuration 8, BETA = 0, MACH = 1.2

SYMBOL	RUN	MACH
□	257	0.6
○	268	0.9
△	28C	1.2

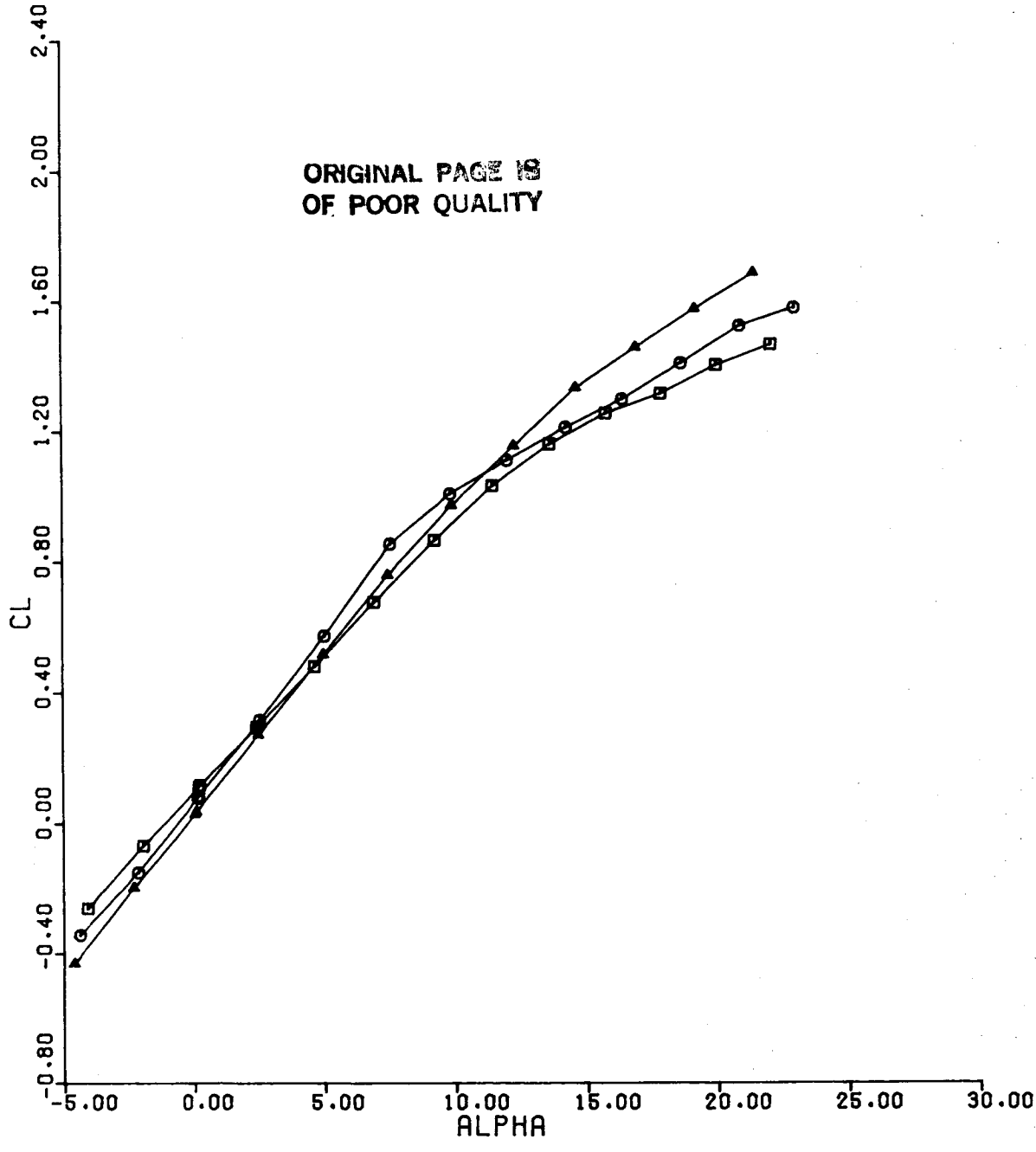

Figure 76(a). CL vs ALPHA
Configuration 8, BETA = 0, DC = 0

SYMBOL	RUN	MACH
□	257	0.6
○	268	0.9
△	280	1.2

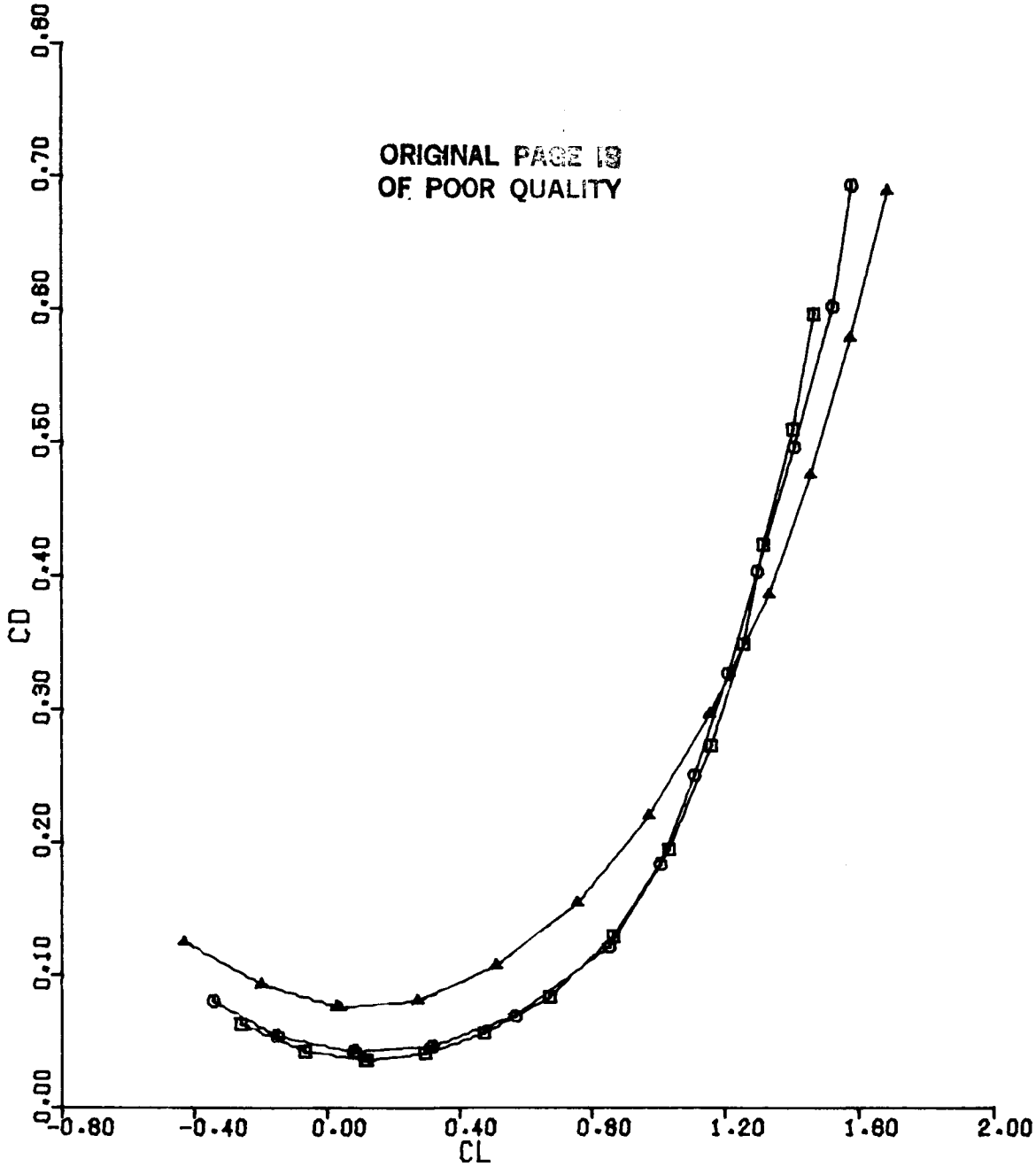

Figure 76(b). CD vs CL
Configuration 8, BETA = 0, DC = 0

SYMBOL	RUN	MACH
□	257	0.6
○	268	0.9
△	280	1.2

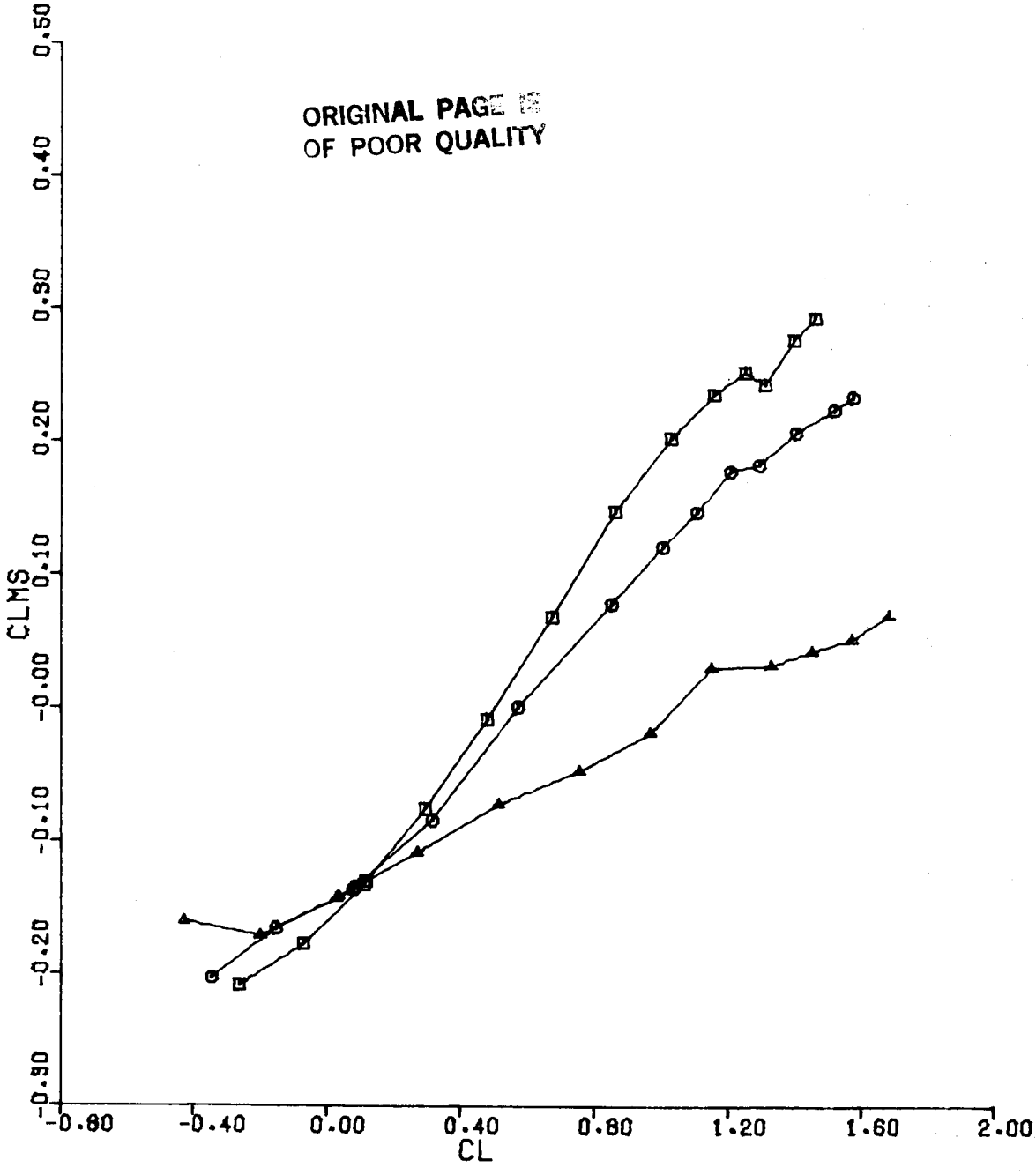

Figure 76(c). CLMS vs CL
Configuration 8, BETA = 0, DC = 0

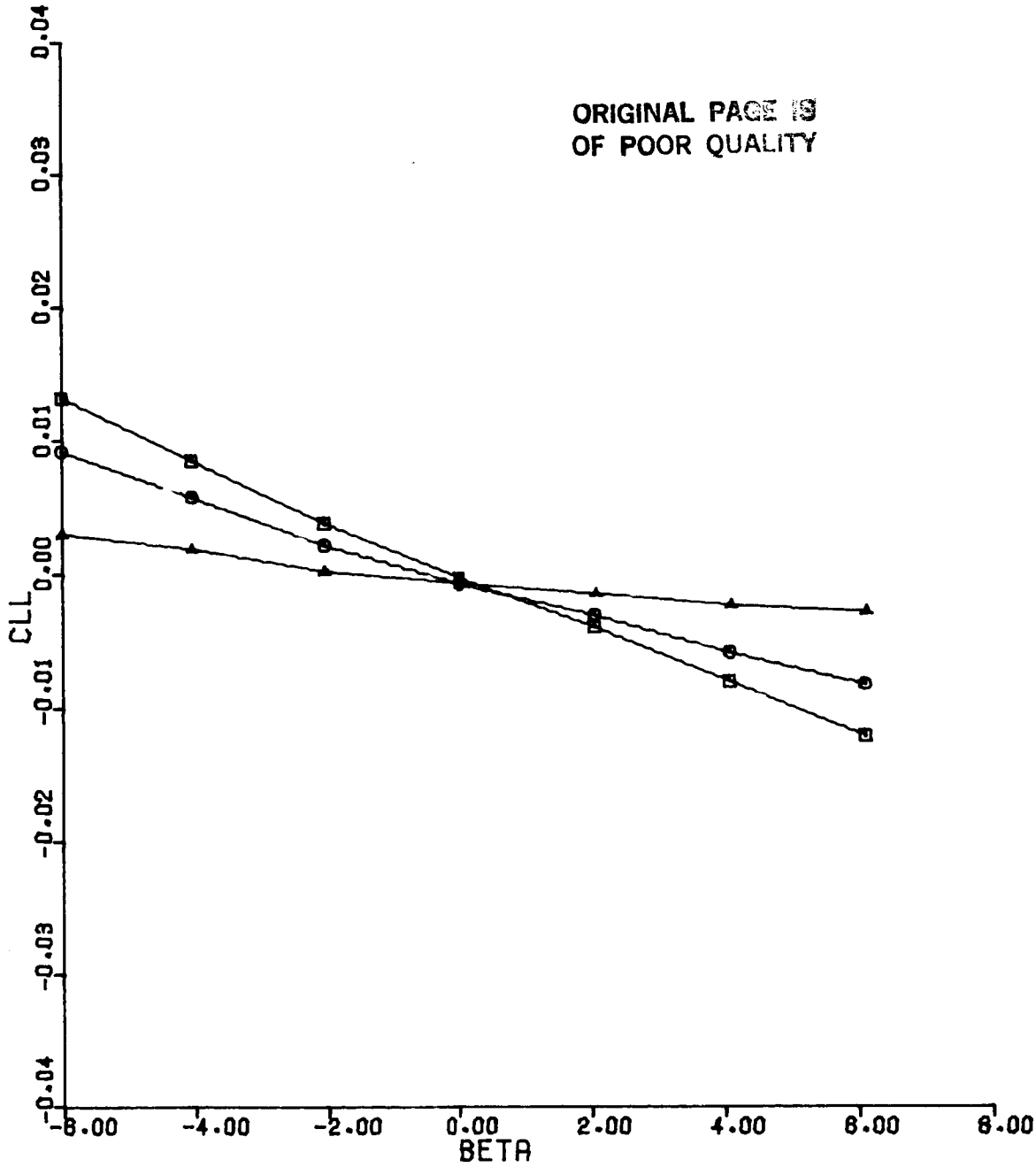

Figure 77(a). CLL vs BETA
Configuration 8, ALPHA = 10, MACH = 0.6

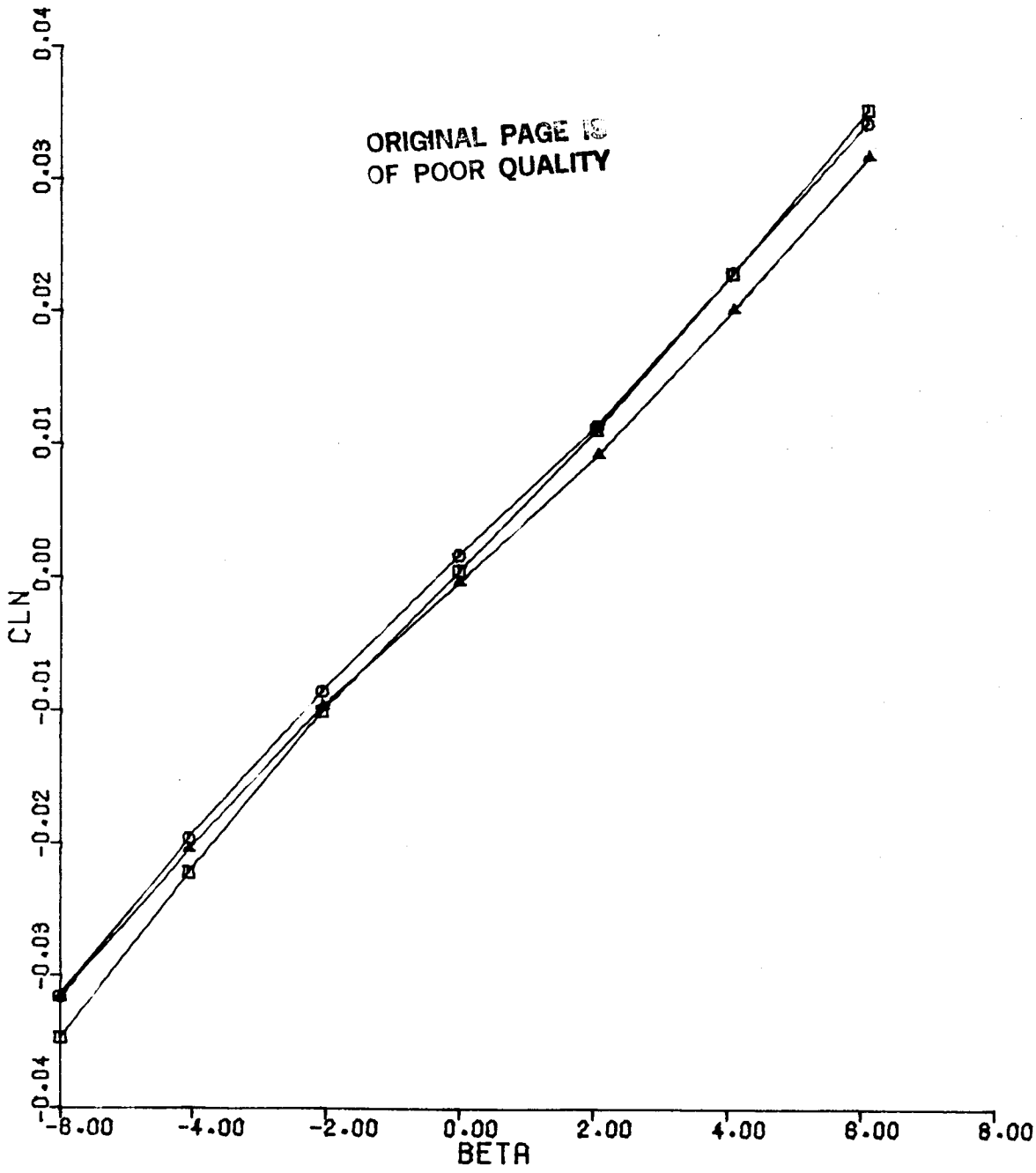

Figure 77(b). CLN vs BETA
Configuration 8, ALPHA = 10, MACH = 0.6

SYMBOL	RUN	DC
□	253	10
○	256	0
△	261	-20

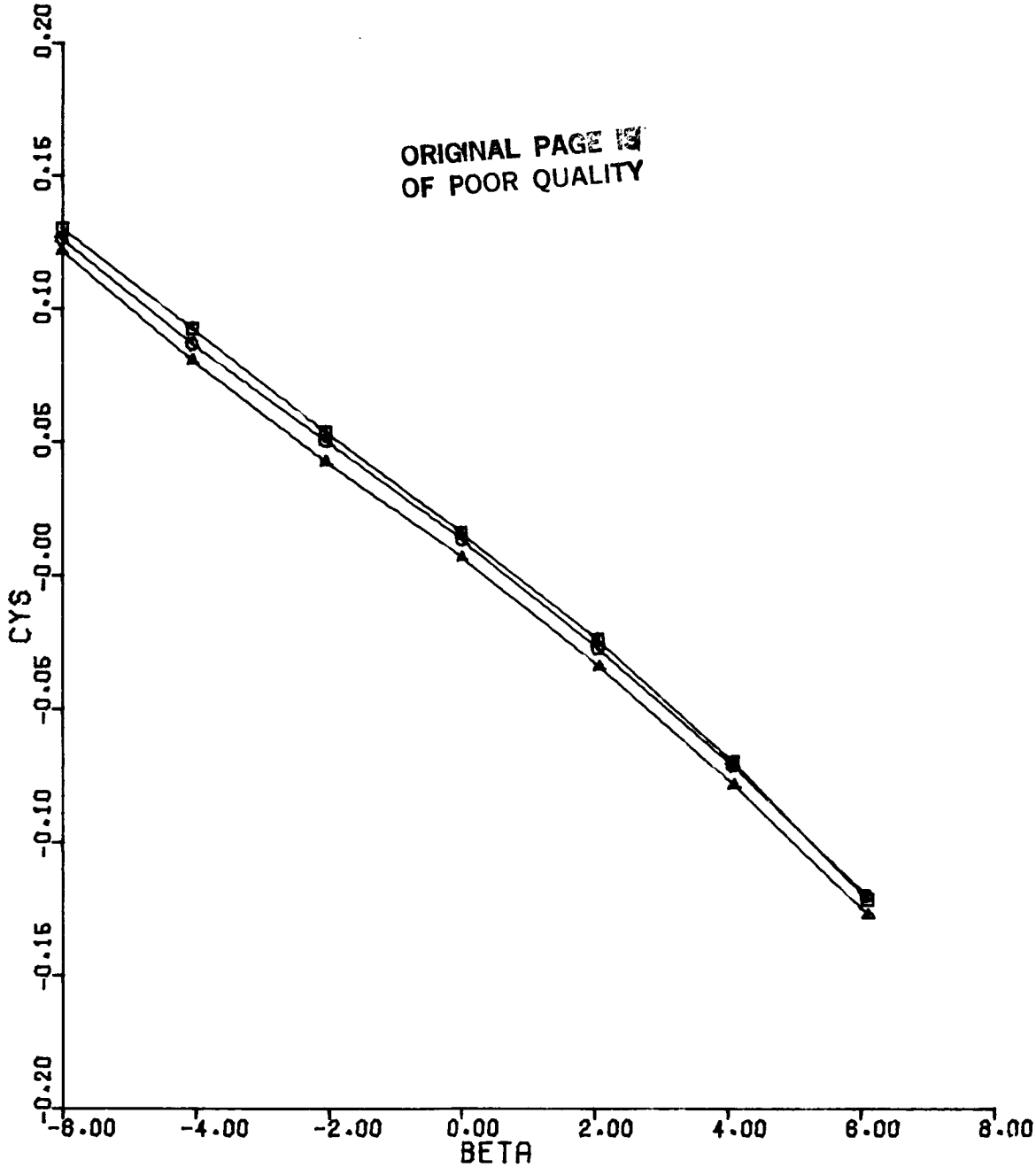

Figure 77(c). CYS vs BETA
Configuration 8, ALPHA = 10, MACH = 0.6

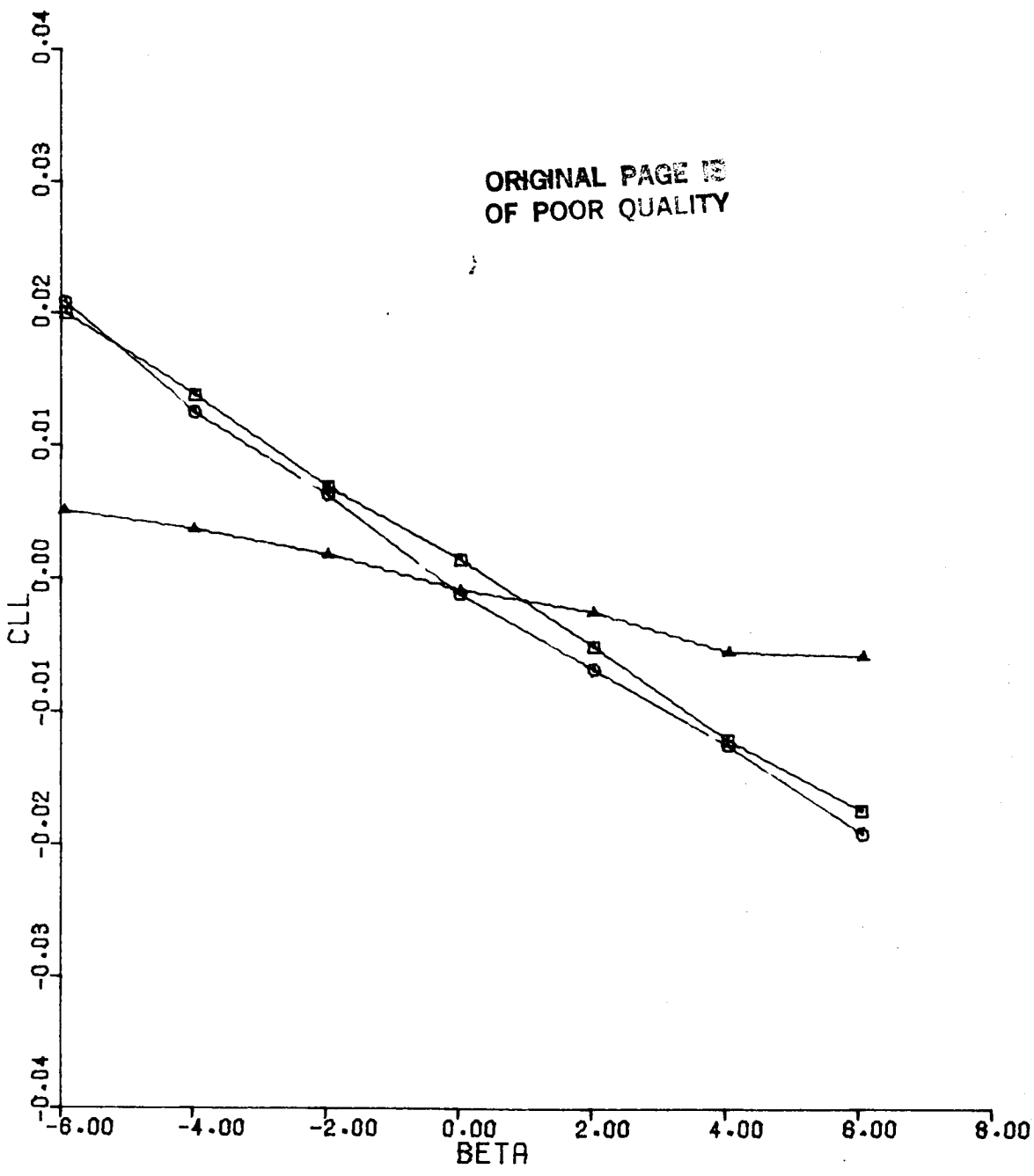

Figure 78(a). CLL vs BETA
Configuration 8, ALPHA = 15, MACH = 0.6

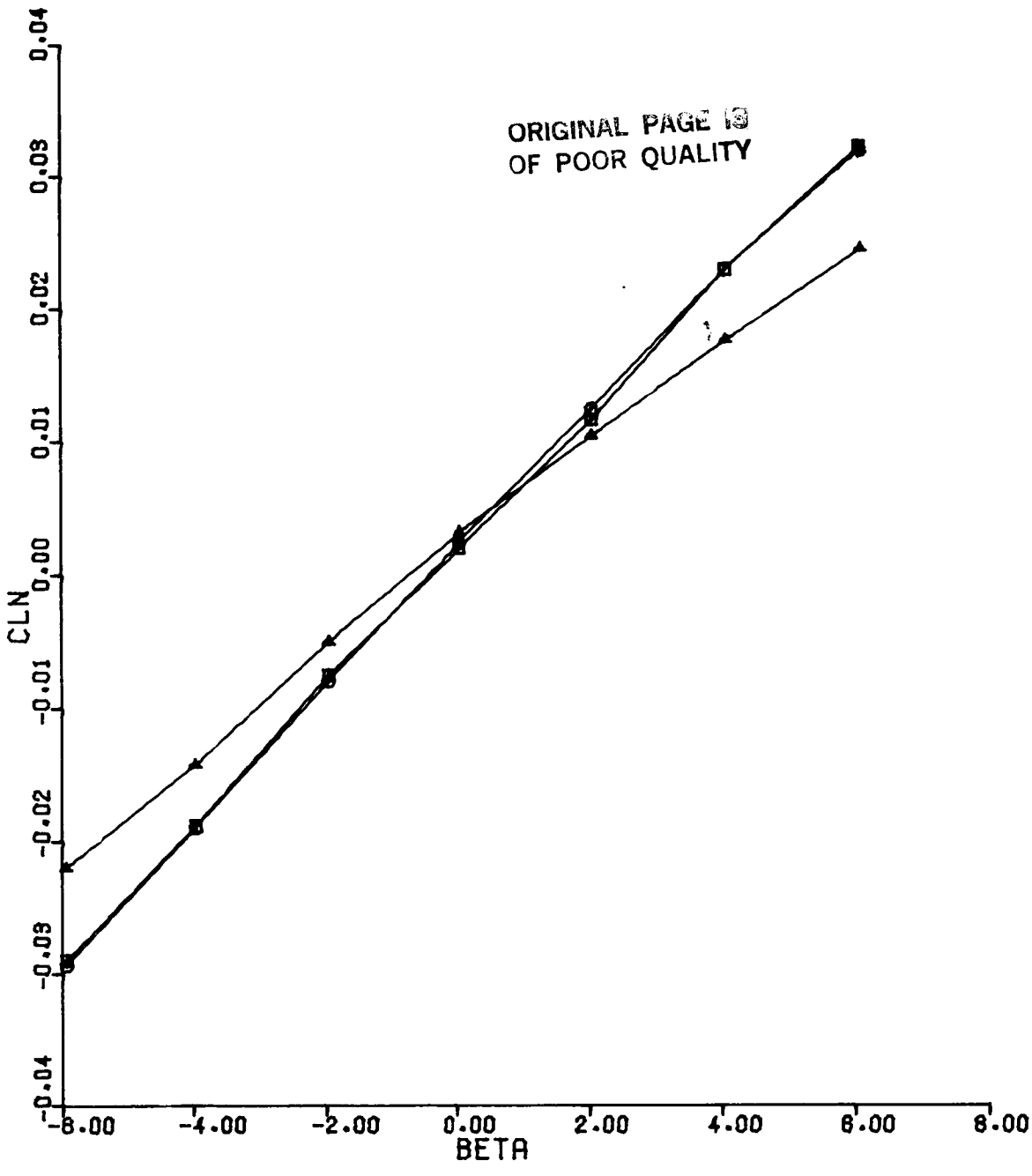

Figure 78(b). CLN vs BETA
Configuration 8, ALPHA = 15, MACH = 0.6

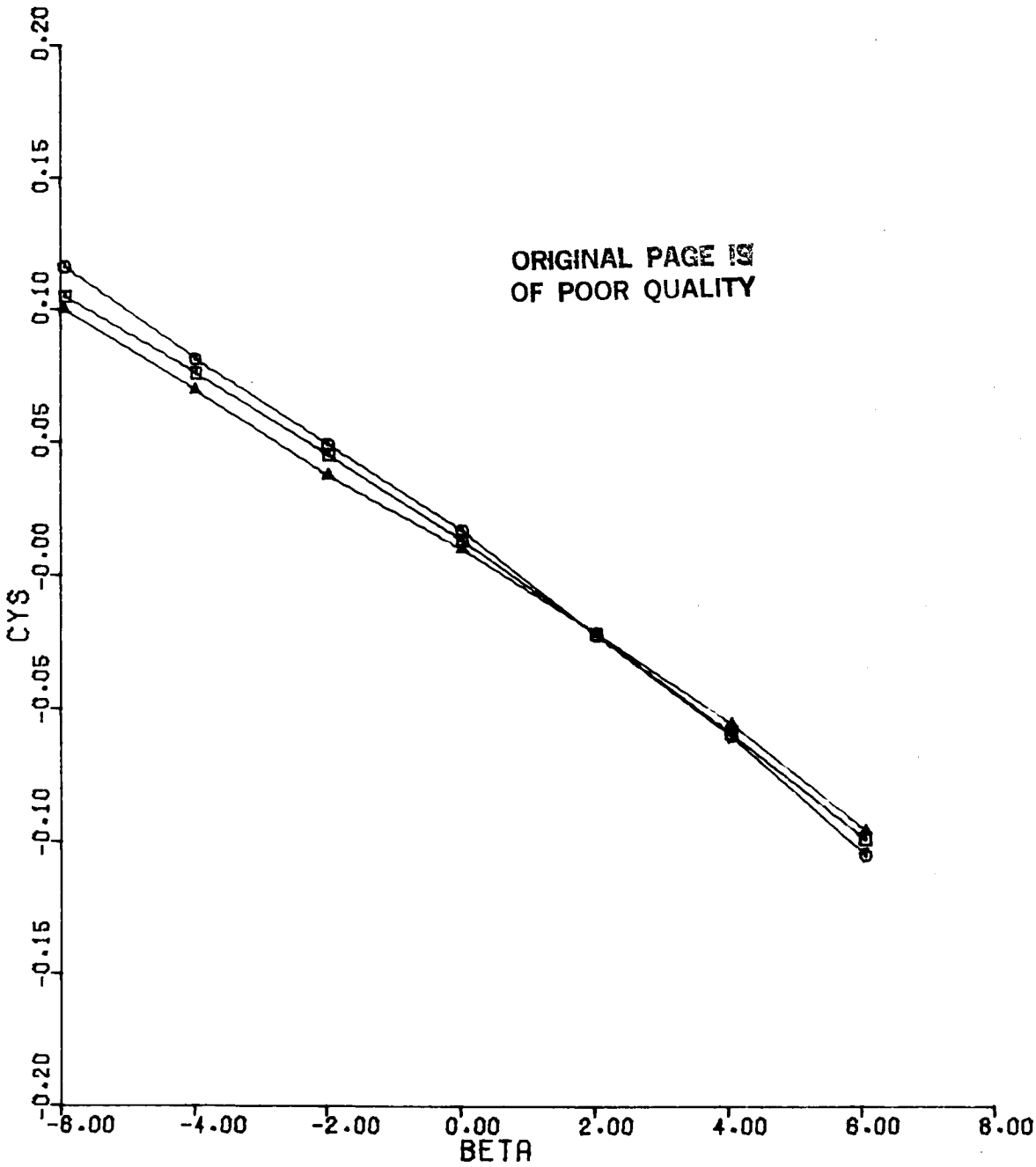

Figure 78(c). CYS vs BETA
Configuration 8, ALPHA = 15, MACH = 0.6

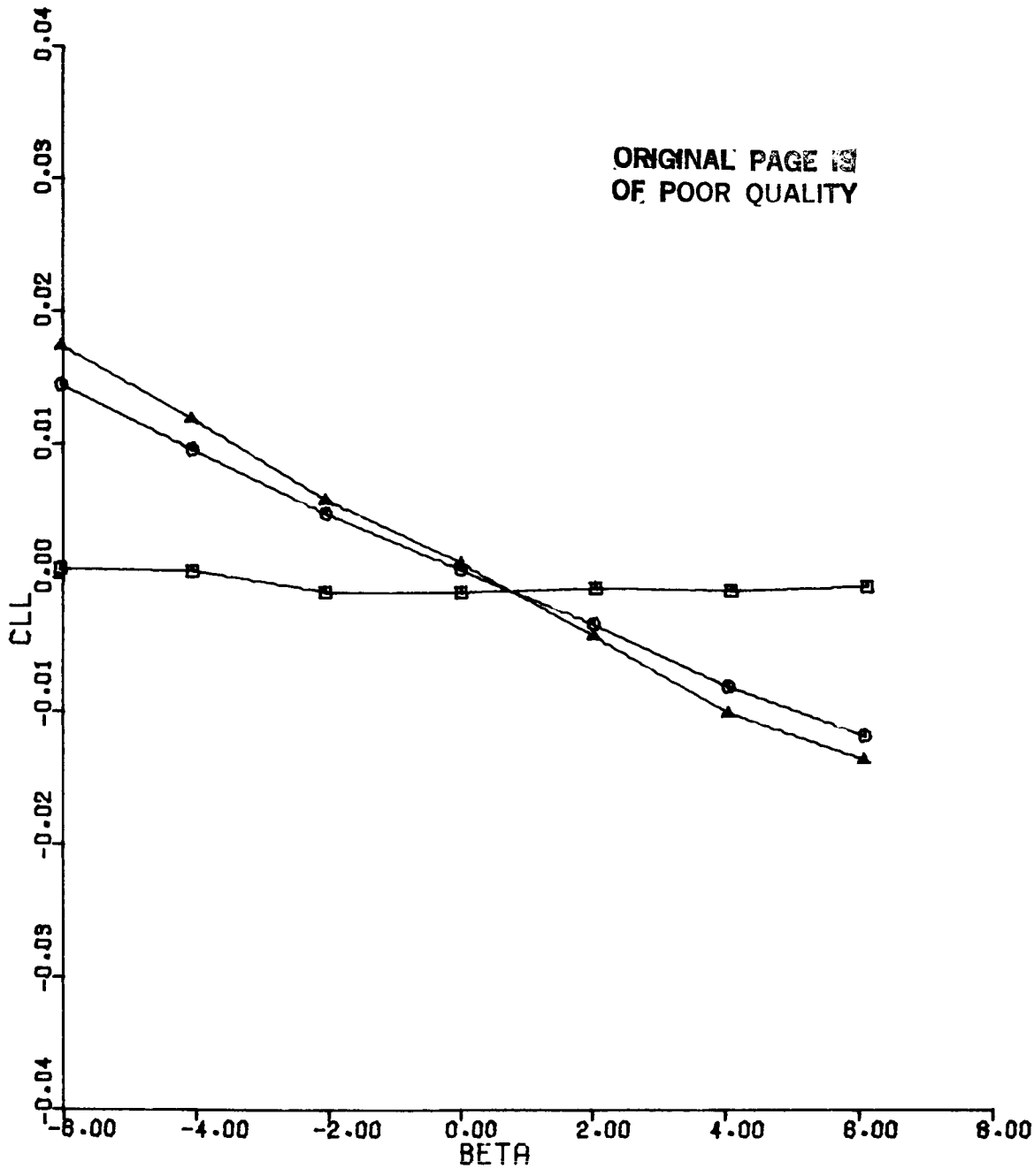

Figure 79(a). CLL vs BETA
Configuration 8, ALPHA = 10, MACH = 0.9

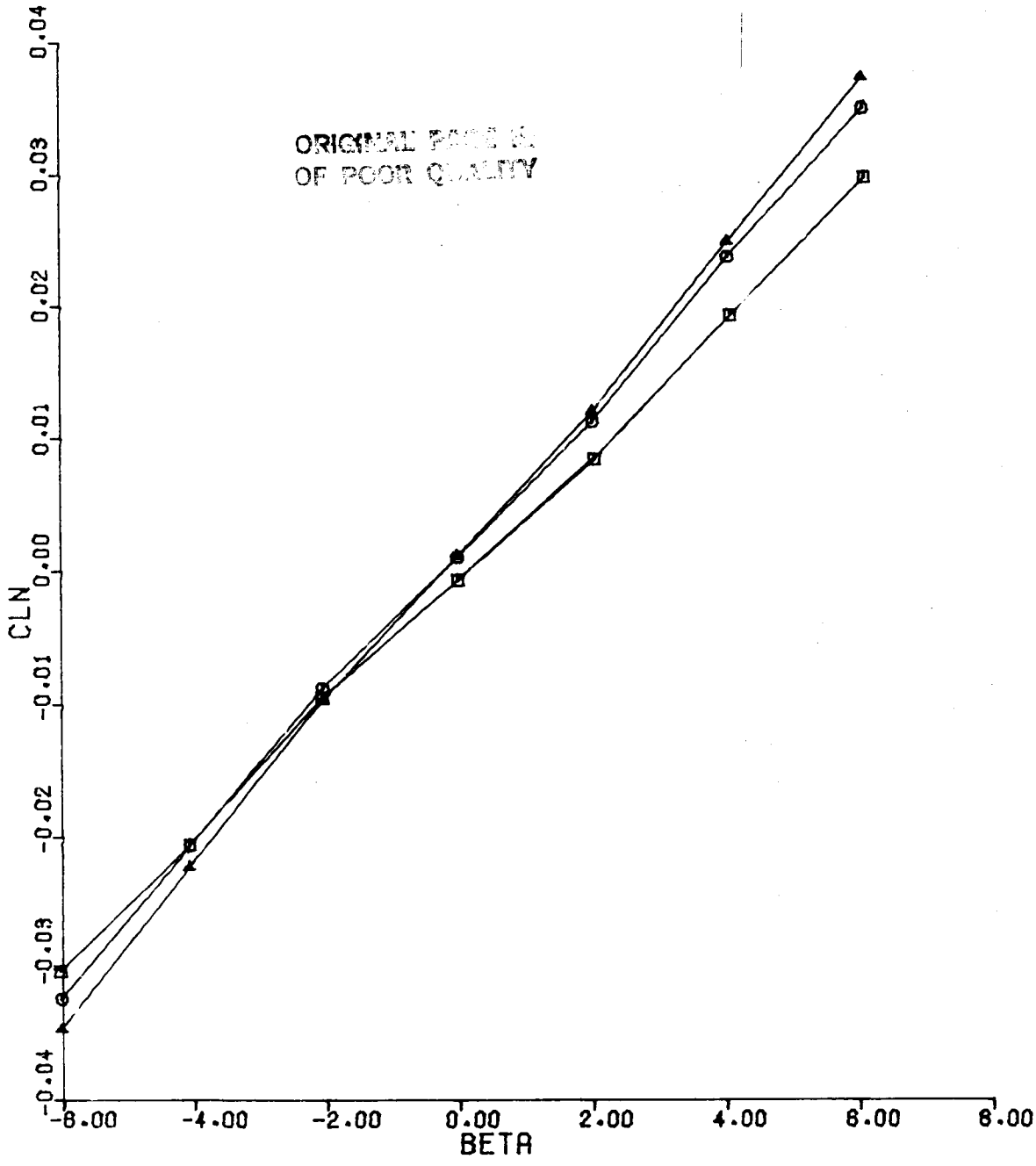

Figure 79(b). CLN vs BETA
Configuration 8, ALPHA = 10, MACH = 0.9

SYMBOL	RUN	DC
□	264	-20
○	269	0
△	272	10

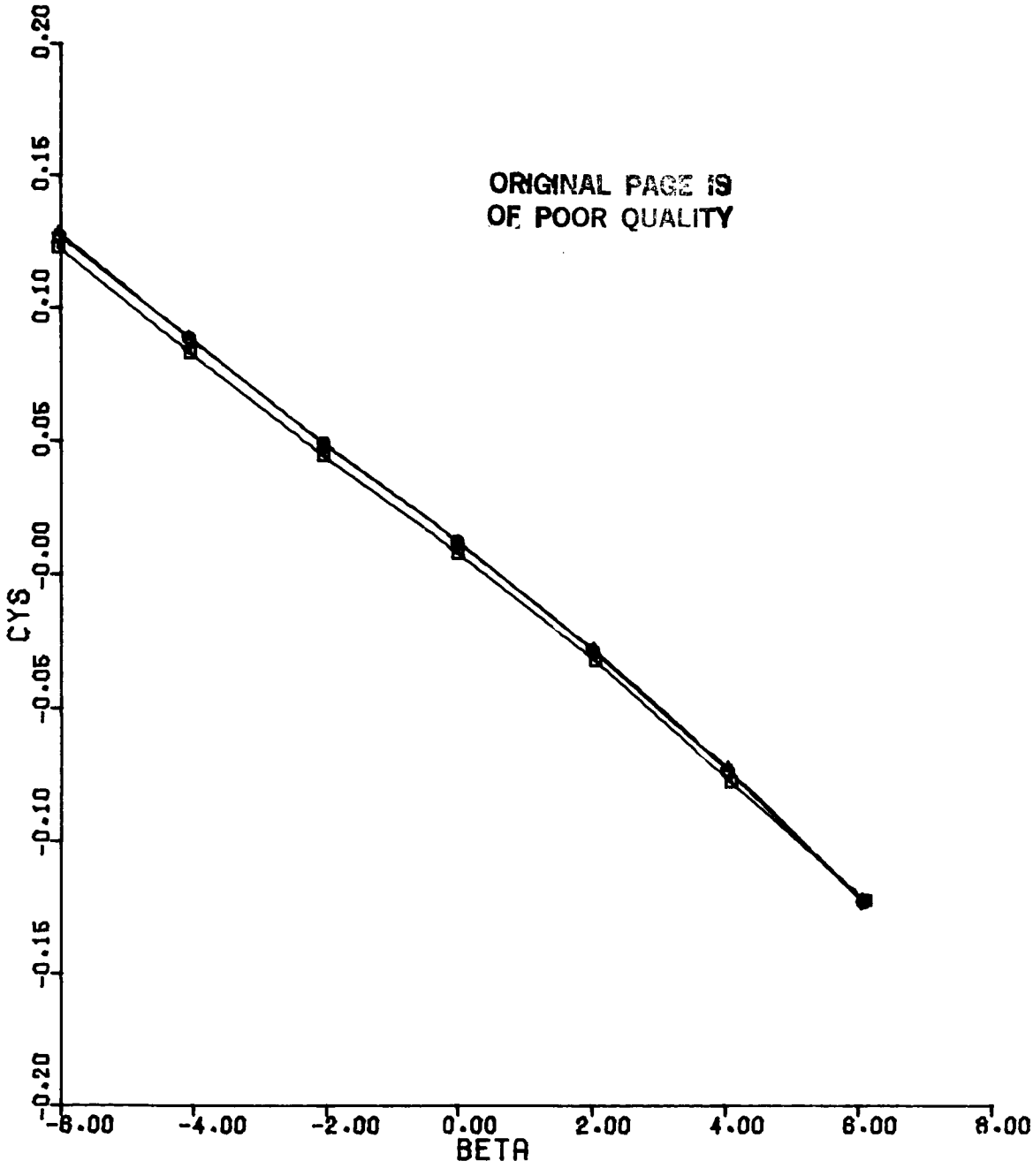

Figure 79(c). CYS vs BETA
Configuration 8, ALPHA = 10, MACH = 0.9

SYMBOL	RUN	DC
□	263	-20
○	270	0
△	271	10

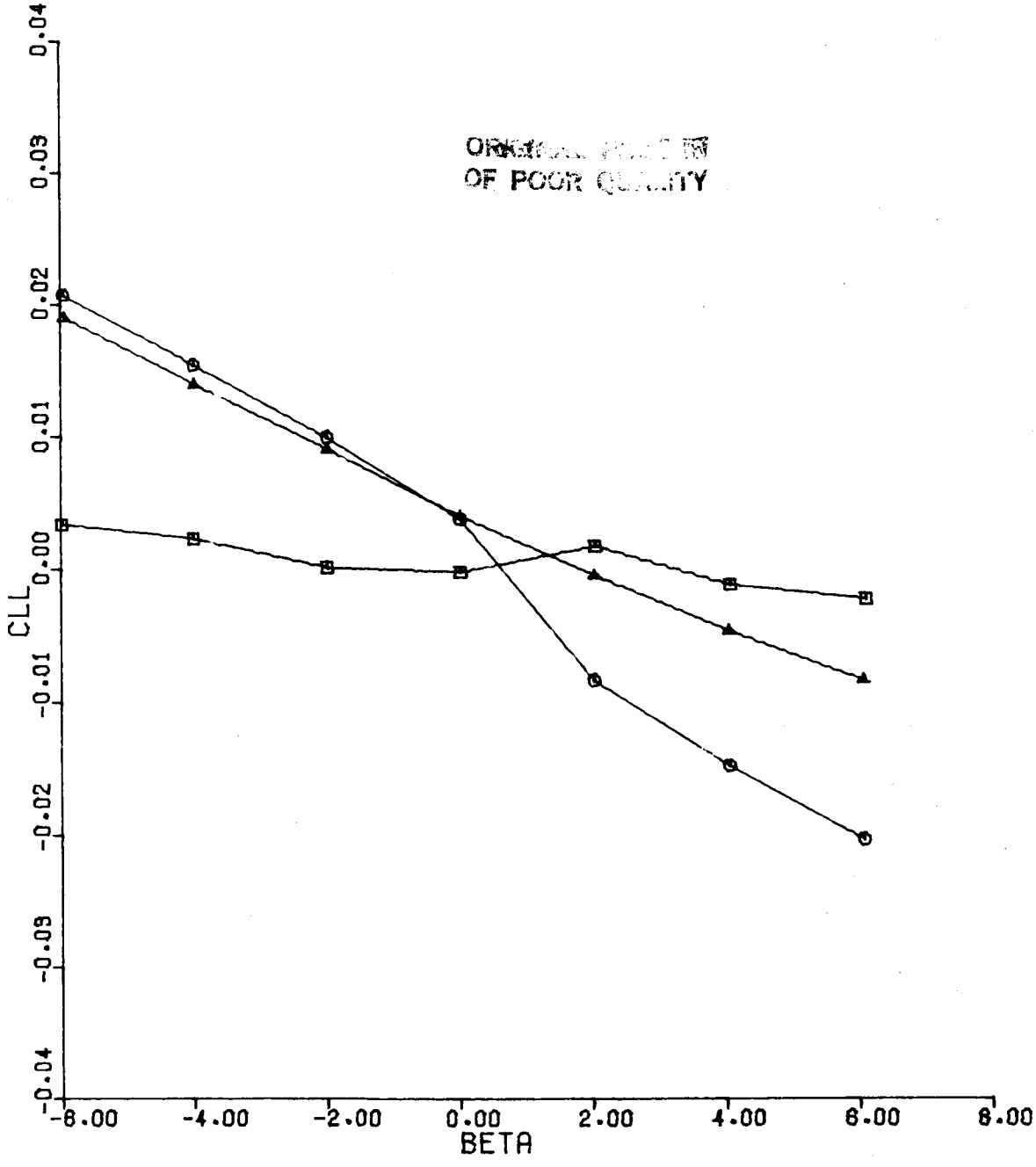

Figure 80(a). CLL vs BETA
Configuration 8, ALPHA = 16, MACH = 0.9

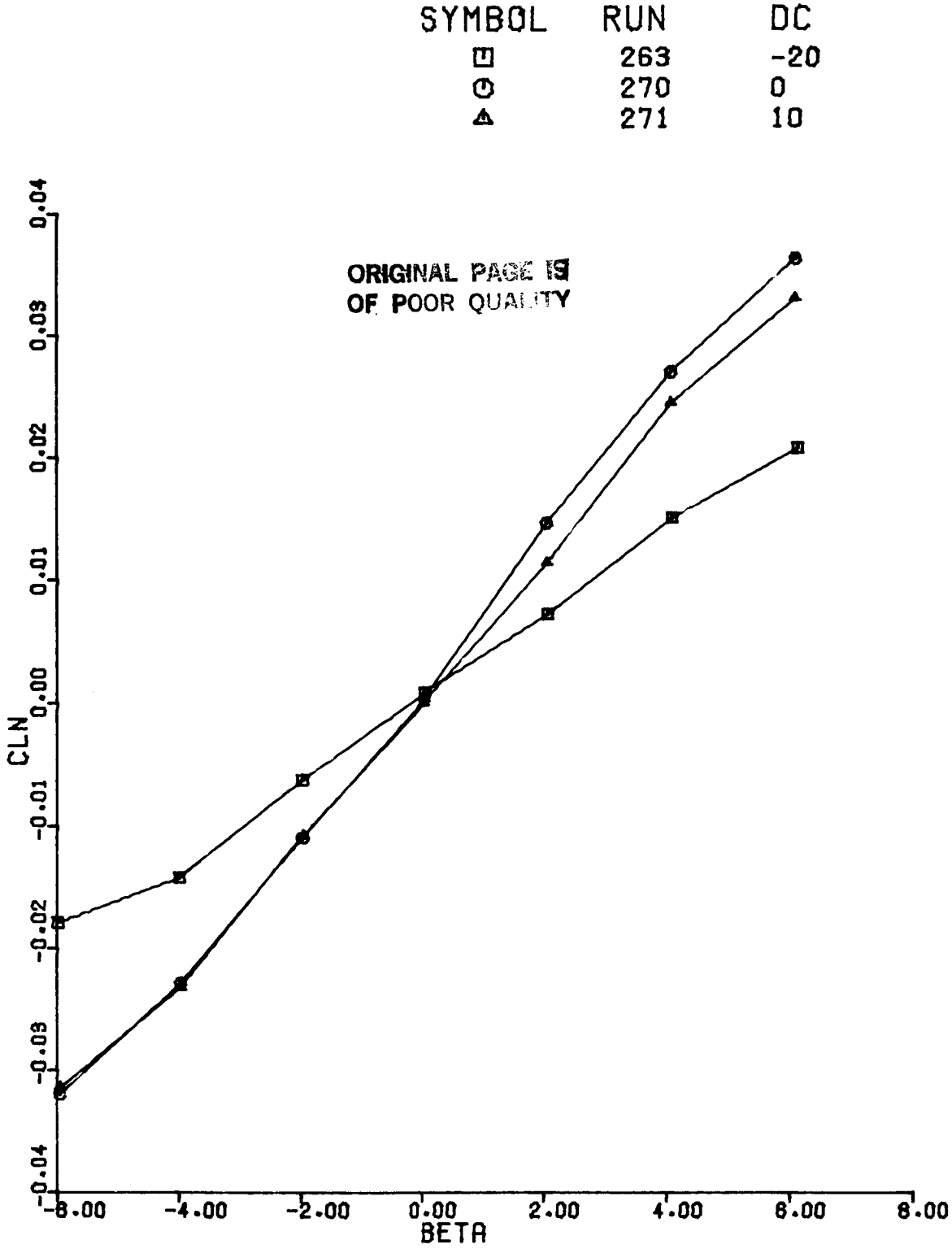

Figure 80(b). CLN vs BETA
Configuration 8, ALPHA = 16, MACH = 0.9

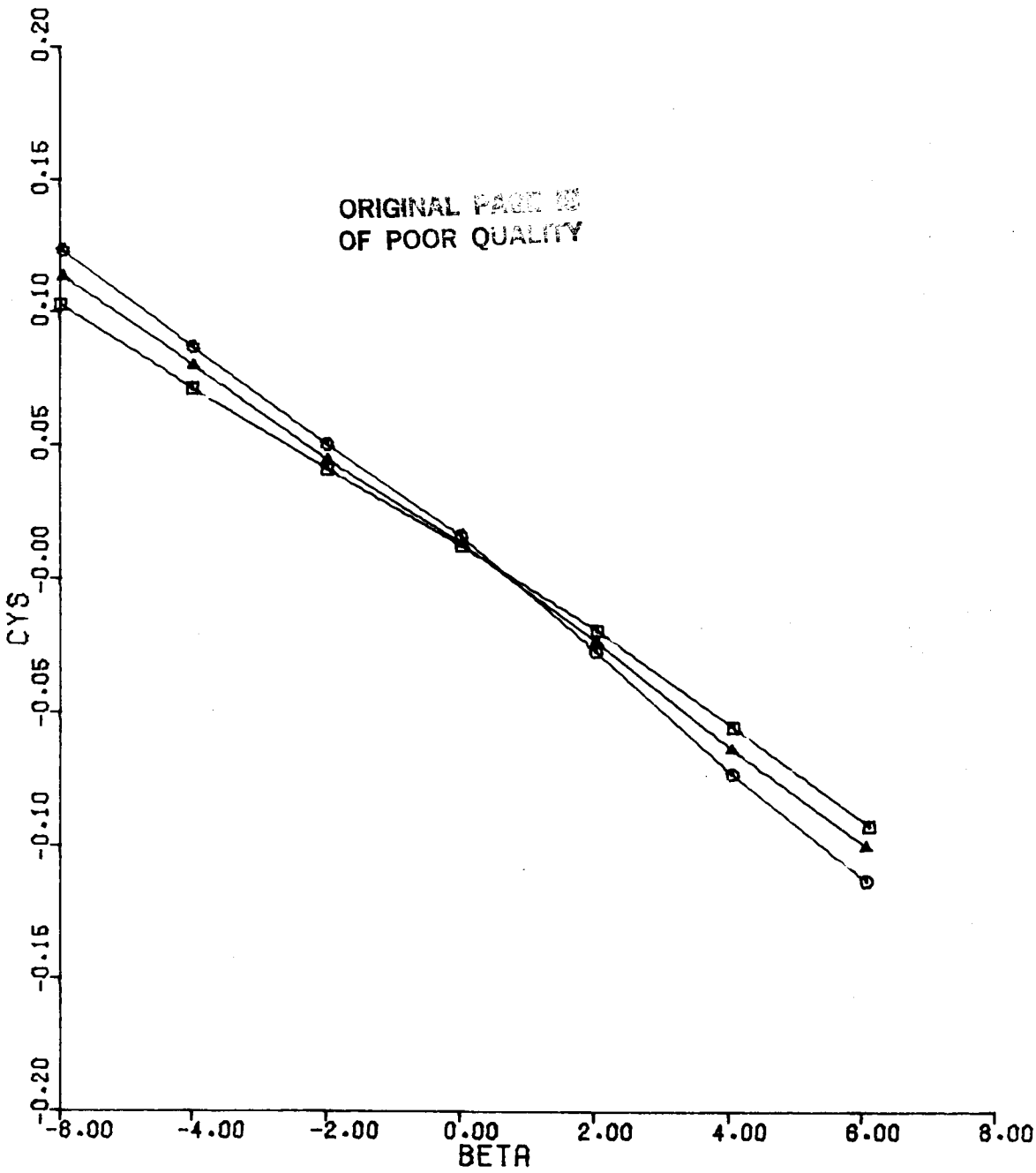

Figure 80(c). CYS vs BETA
Configuration 8, ALPHA = 16, MACH = 0.9

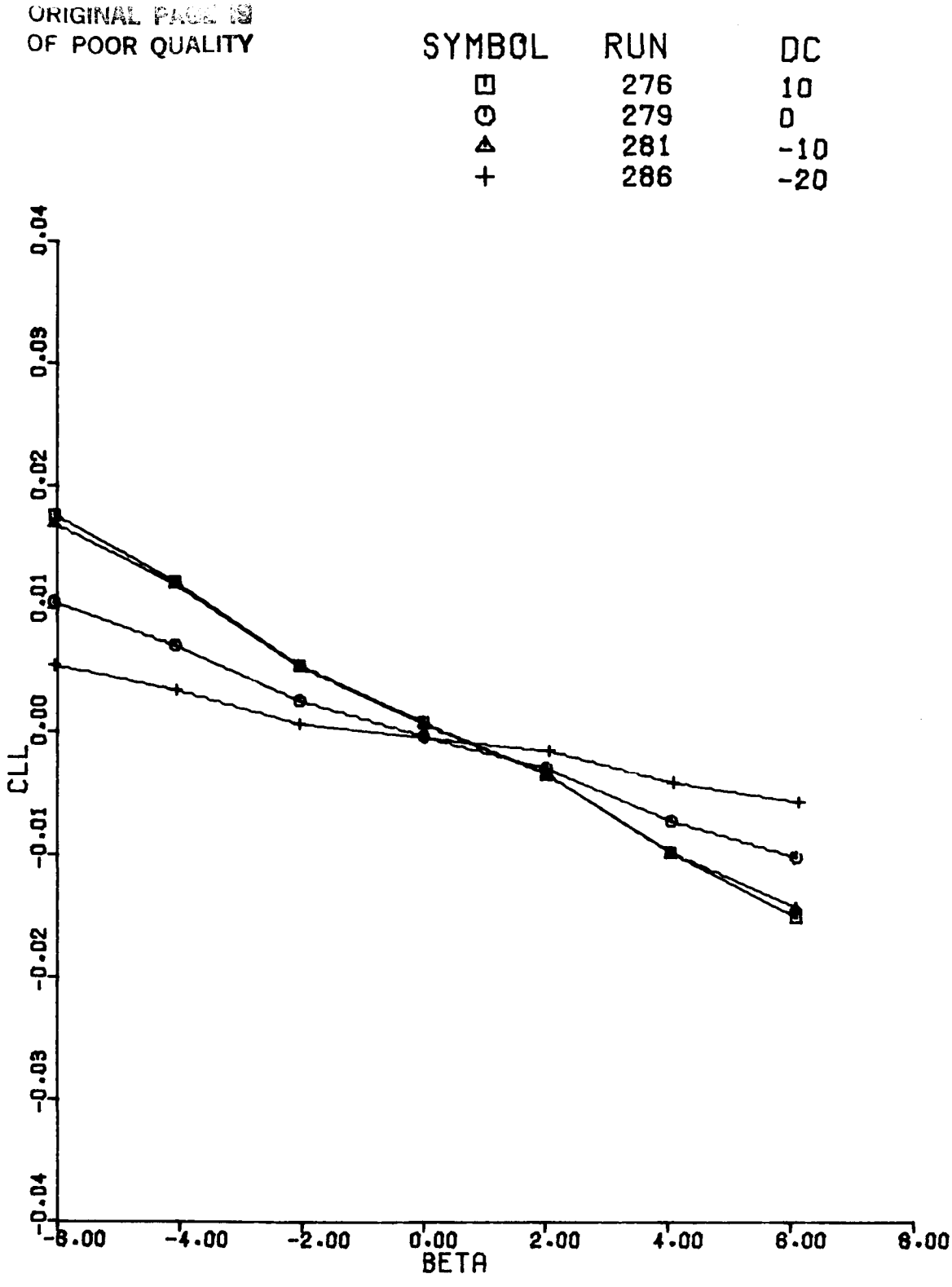

Figure 81(a). CLL vs BETA
Configuration 8, ALPHA = 11, MACH = 1.2

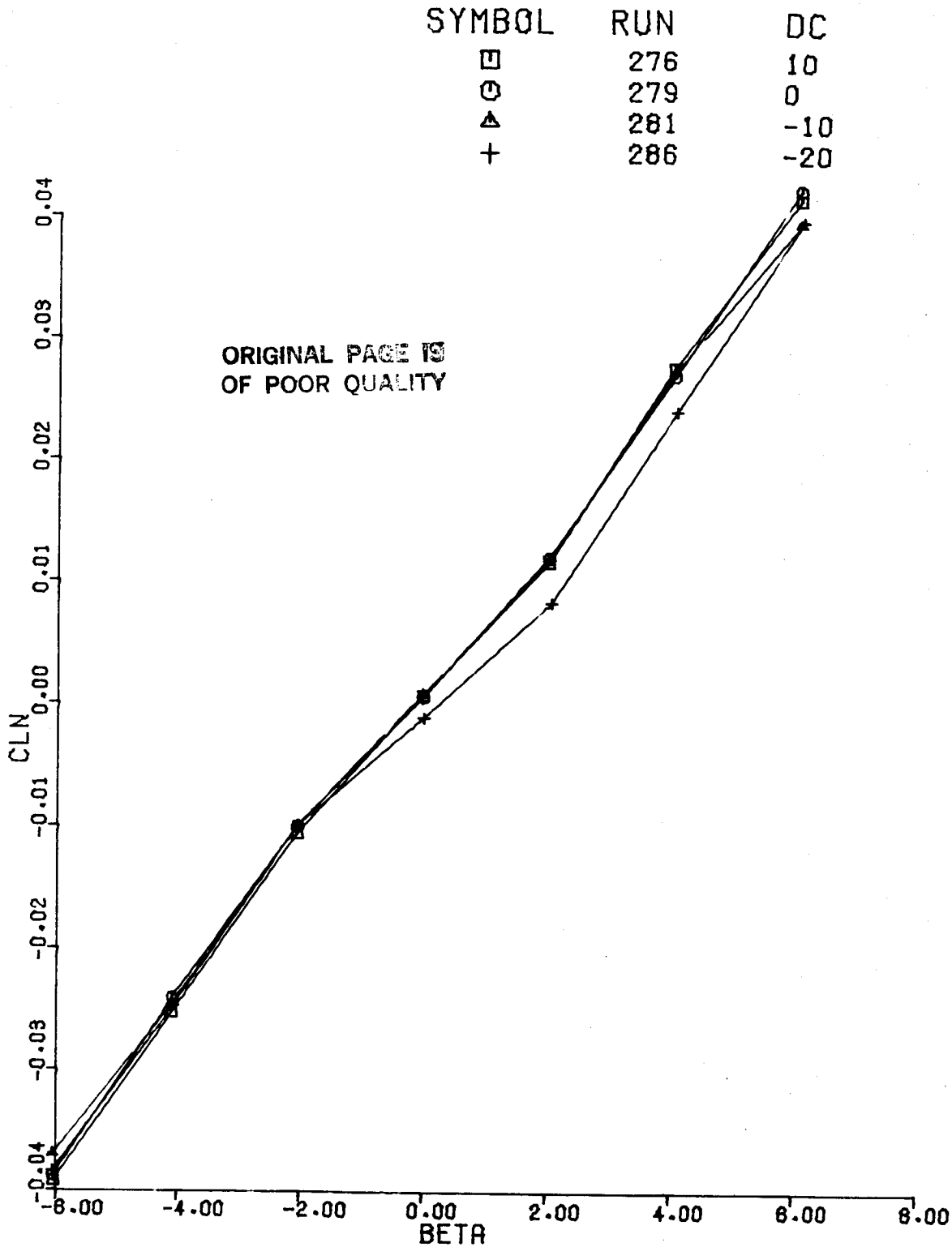

Figure 81(b). CLN vs BETA
Configuration 8, ALPHA = 11, MACH = 1.2

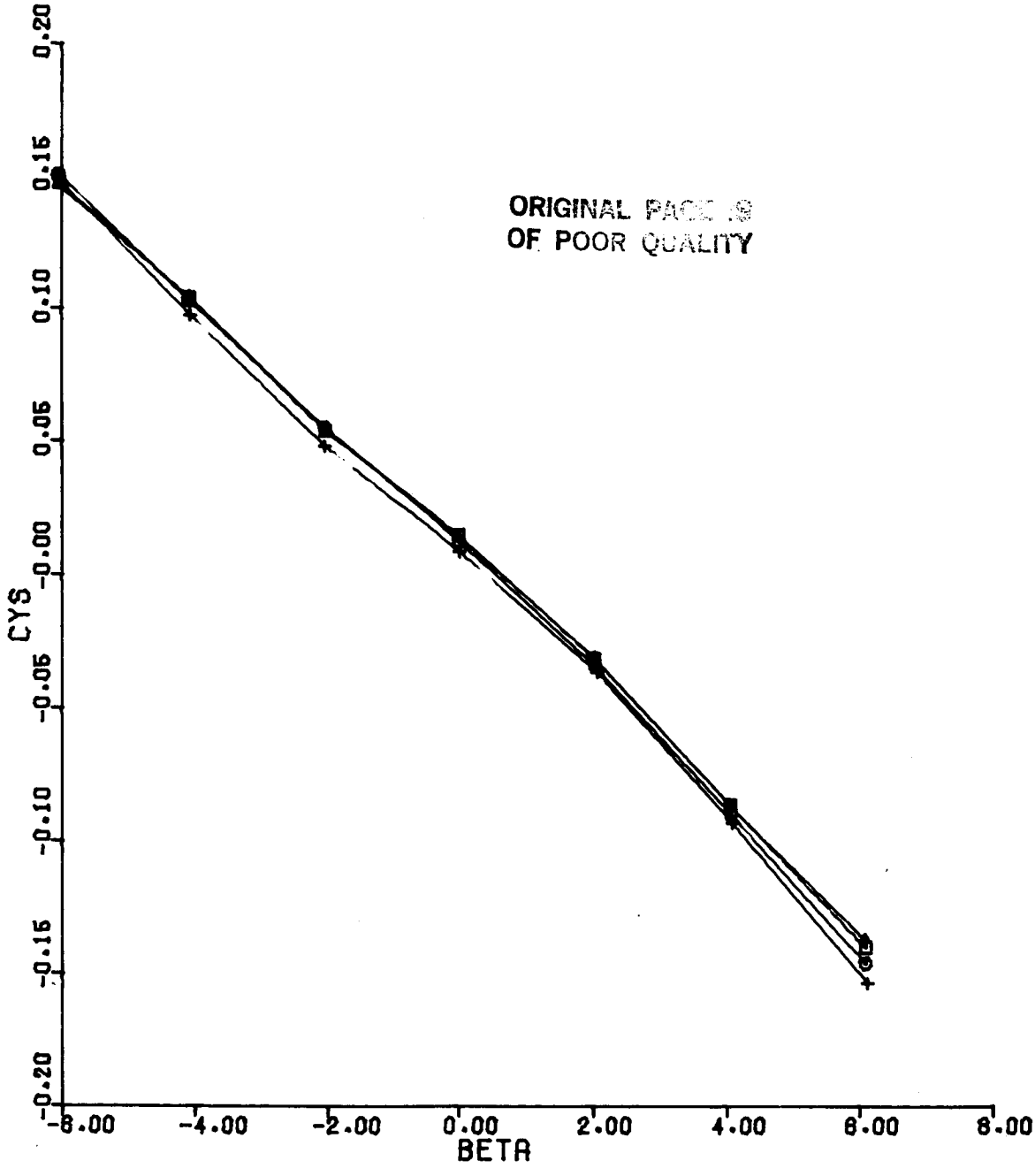

Figure 81(c). CYS vs BETA
Configuration 8, ALPHA = 11, MACH = 1.2

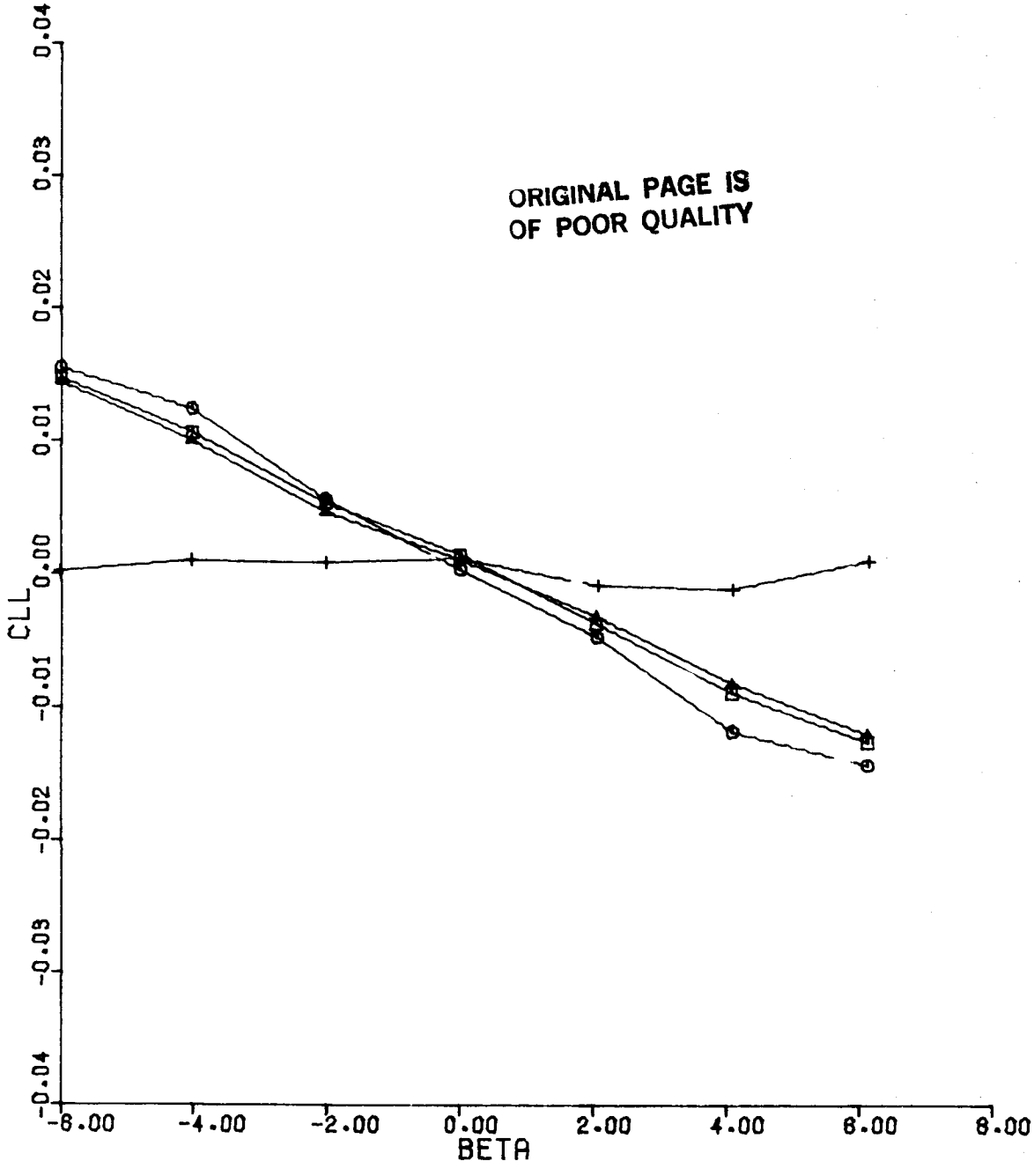

Figure 82(a). CLL vs BETA
Configuration 8, ALPHA = 16, MACH = 1.2

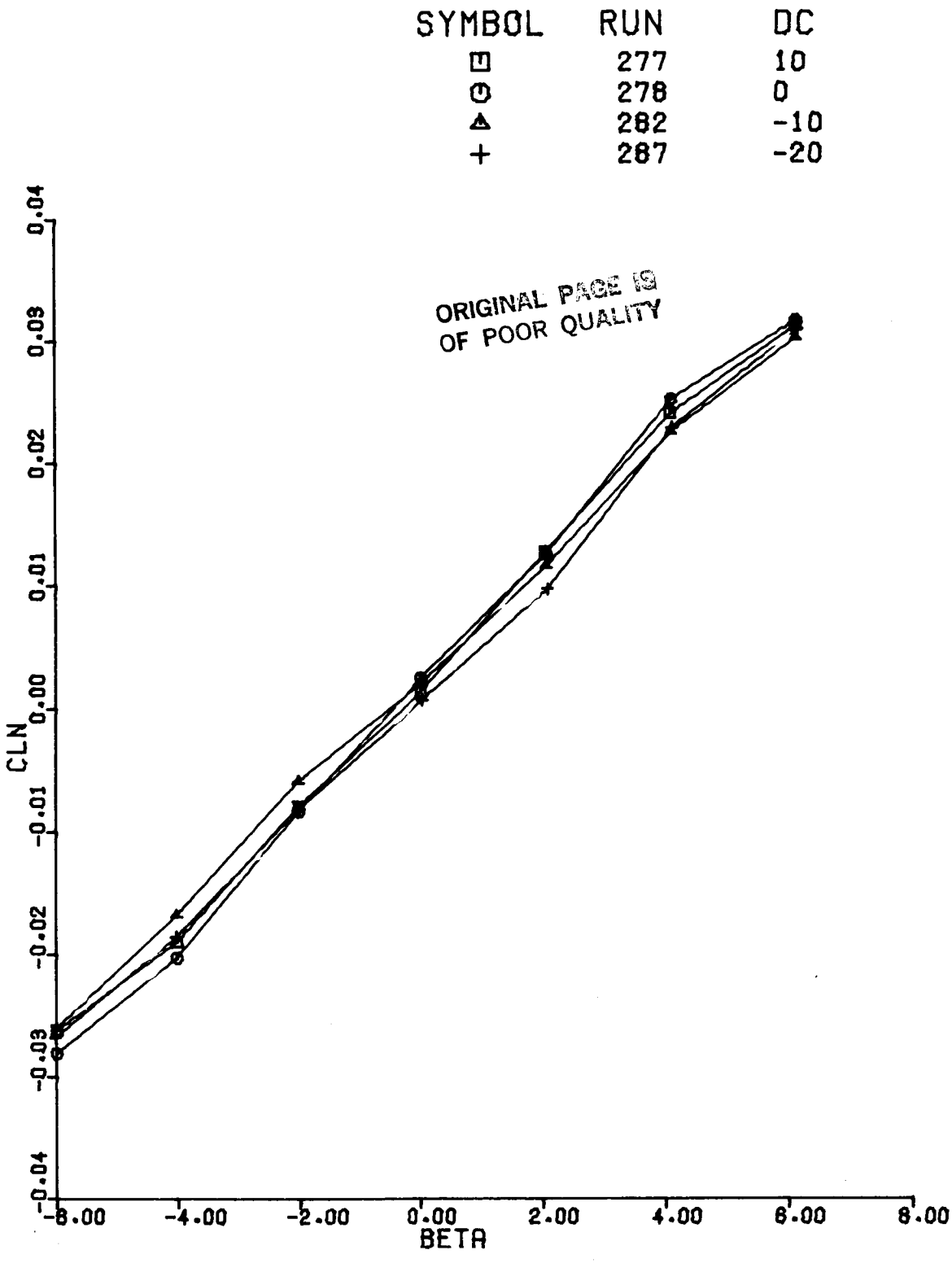

Figure 82(b). CLN vs BETA
Configuration 8, ALPHA = 16, MACH = 1.2

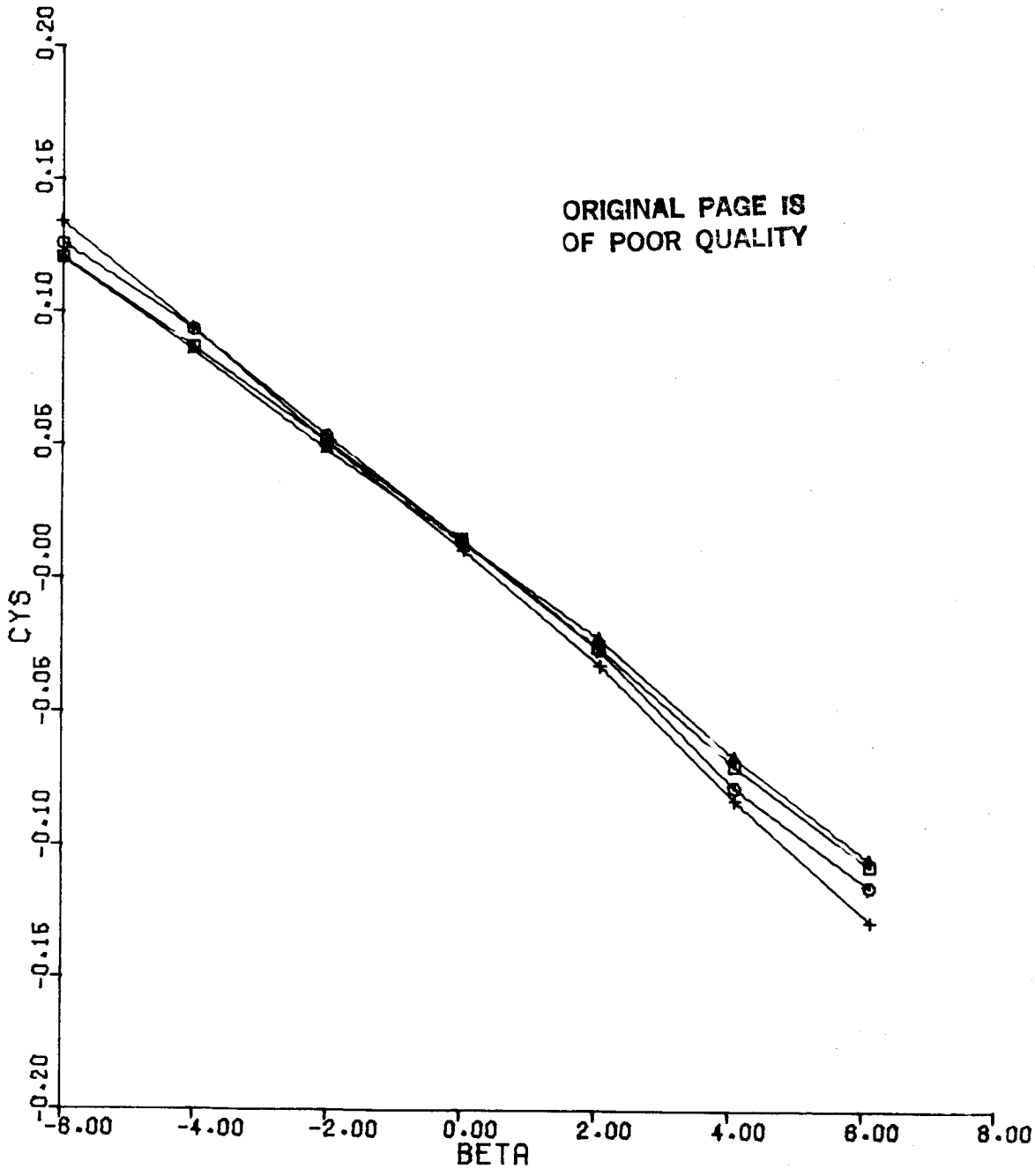

Figure 82(c). CYS vs BETA
Configuration 8, ALPHA = 16, MACH = 1.2

SYMBOL	RUN	DC
⊡	290	-20
⊙	291	0
▲	292	10

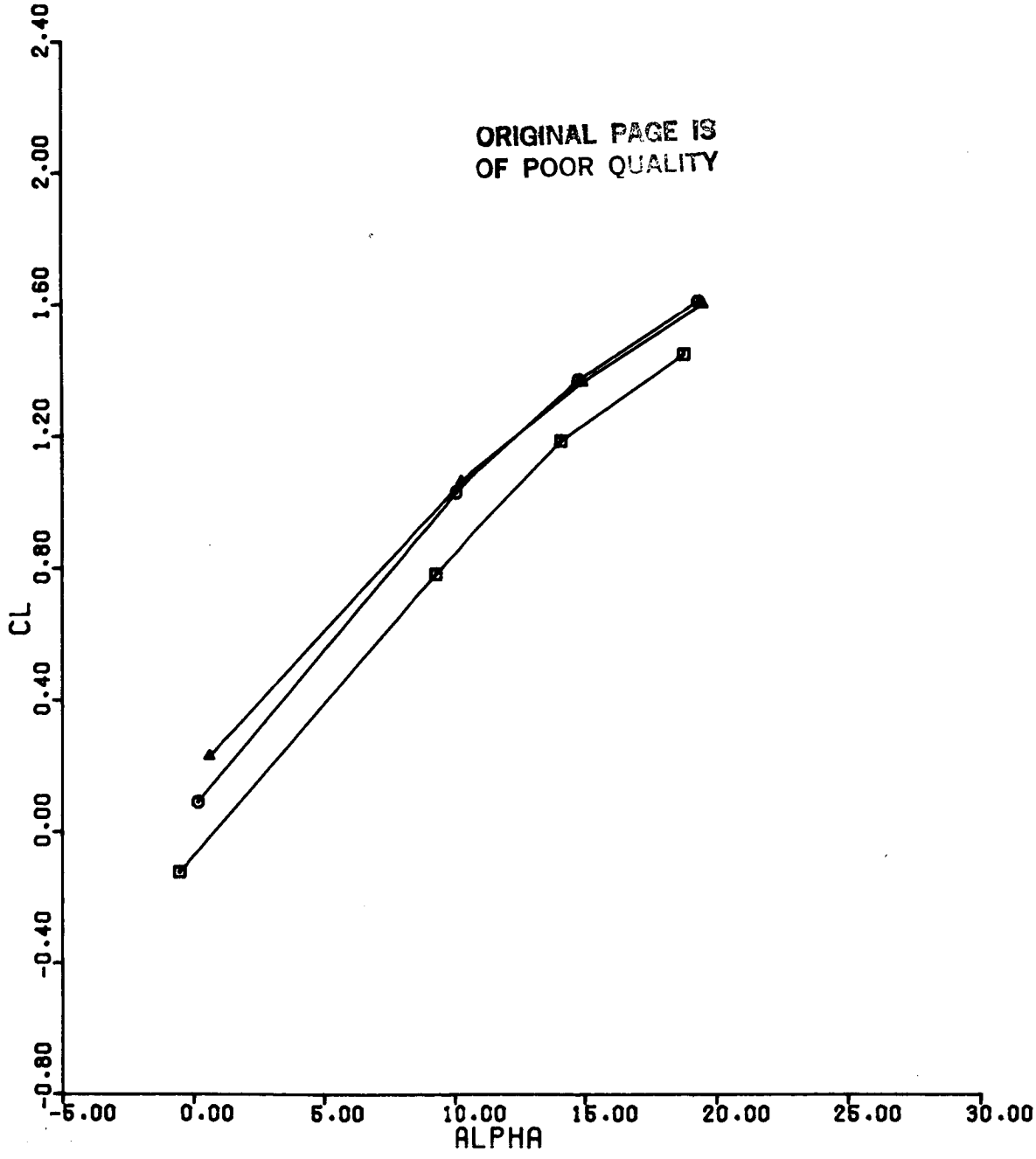

Figure 83(a). CL vs ALPHA
Configuration 9, BETA = 0, MACH = 1.2

SYMBOL	RUN	DC
□	290	-20
○	291	0
△	292	10

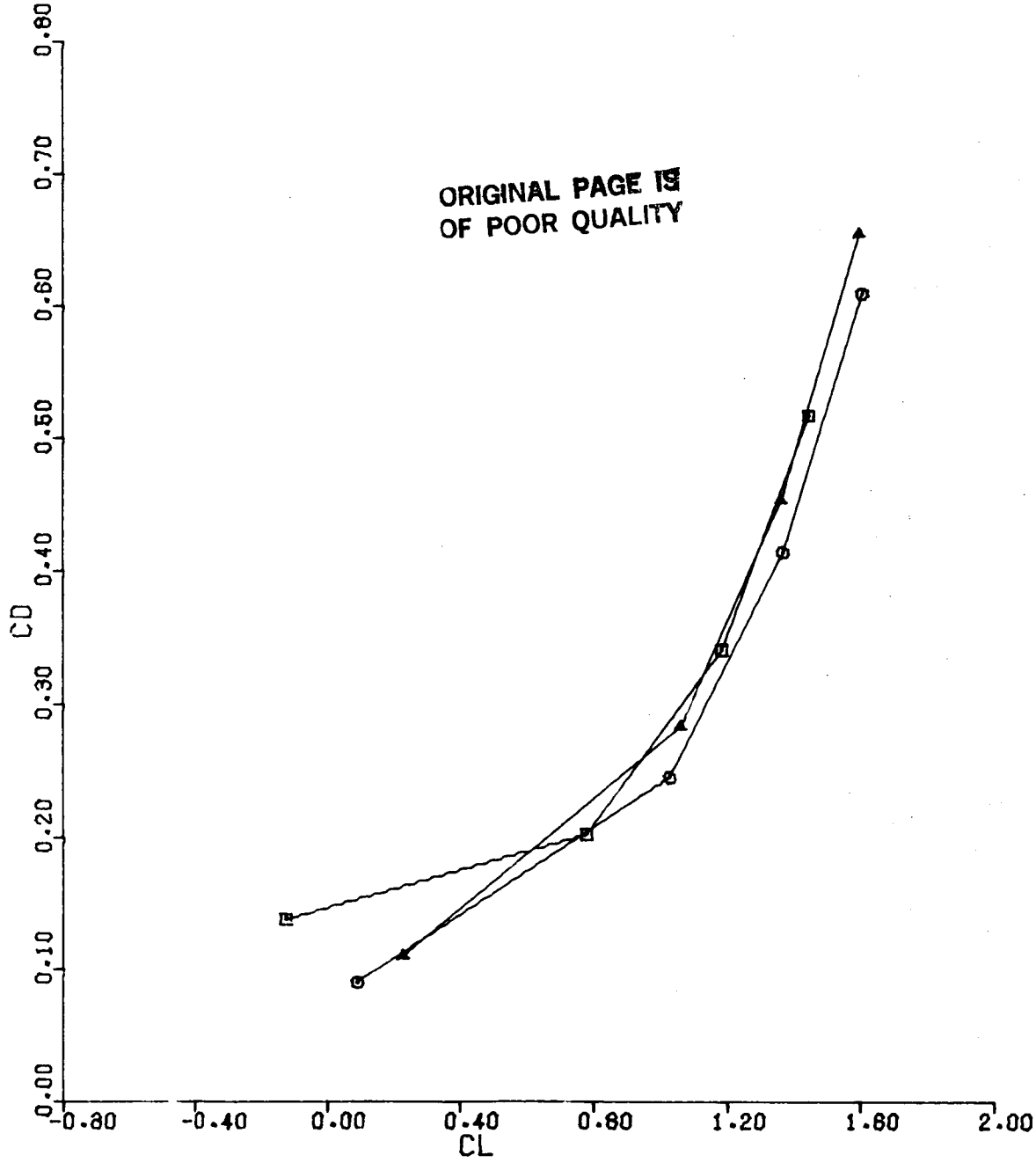

Figure 83(b). CD vs CL
Configuration 9, BETA = 0, MACH = 1.2

SYMBOL	RUN	DC
□	290	-20
○	291	0
△	292	10

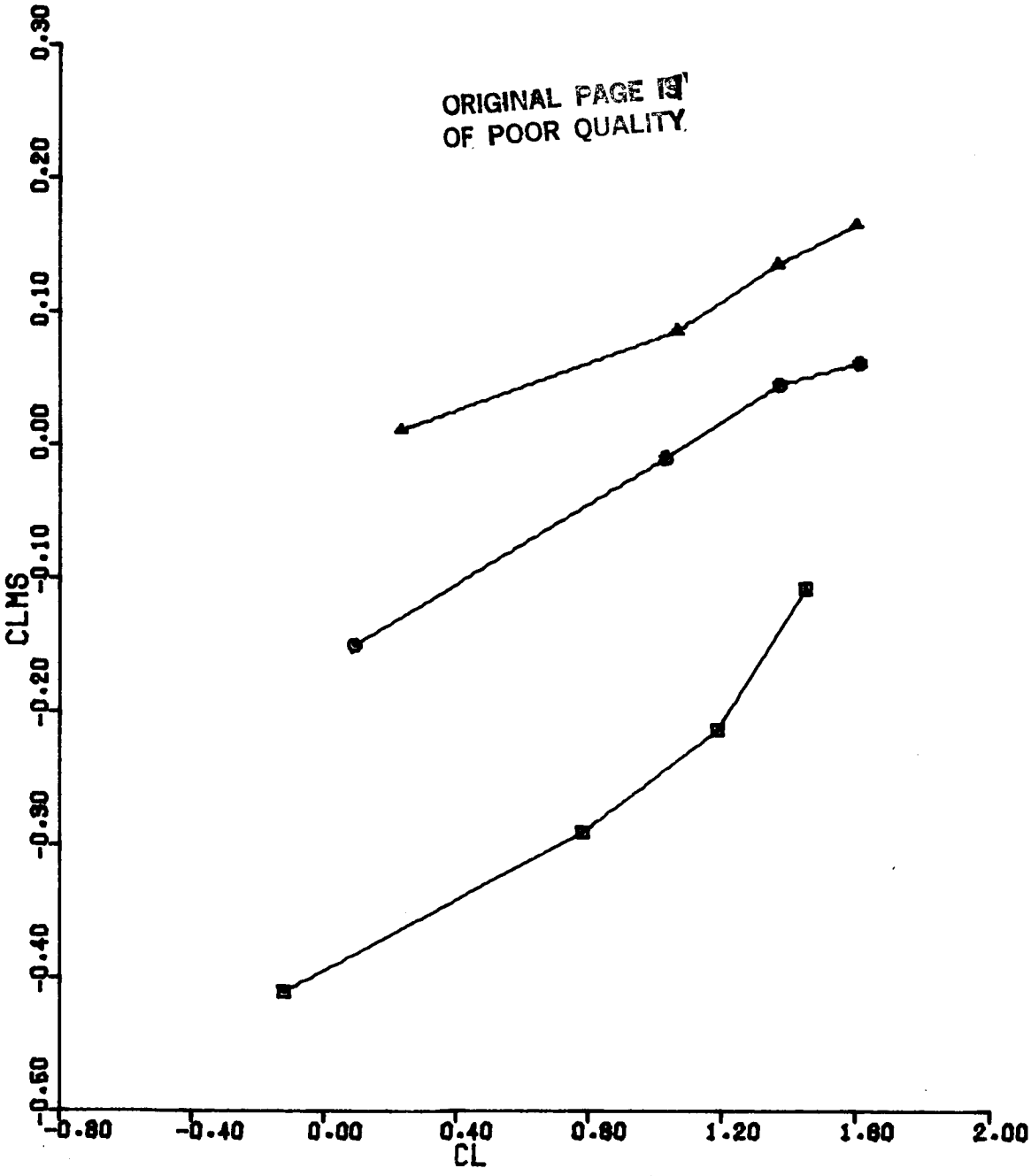

Figure 83(c). CLMS vs CL
Configuration 9, BETA = 0, MACH = 1.2

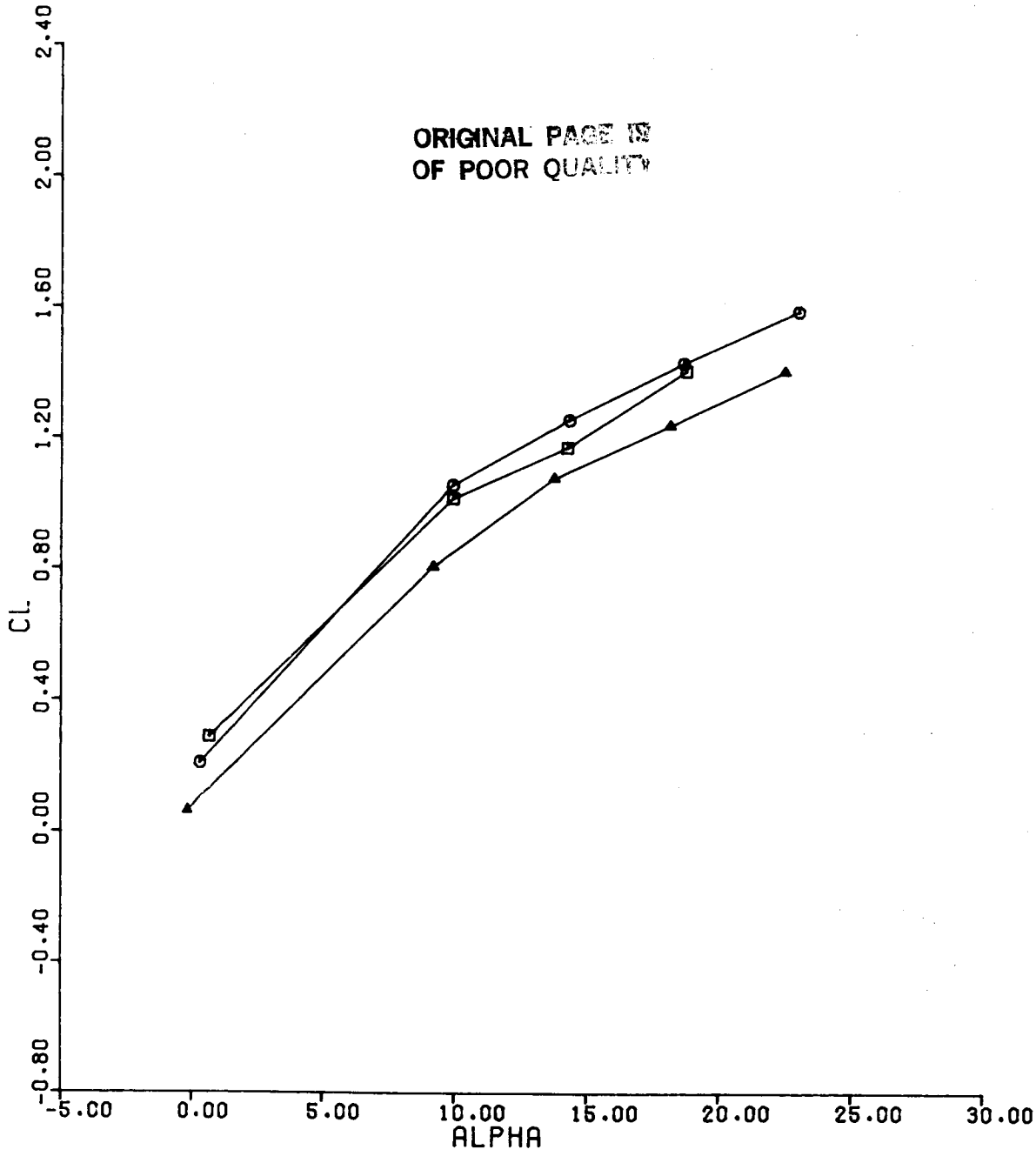

Figure 84(a). CL vs ALPHA
Configuration 9, BETA = 0, MACH = 0.9

SYMBOL	RUN	DC
□	293	10
○	296	0
△	299	-20

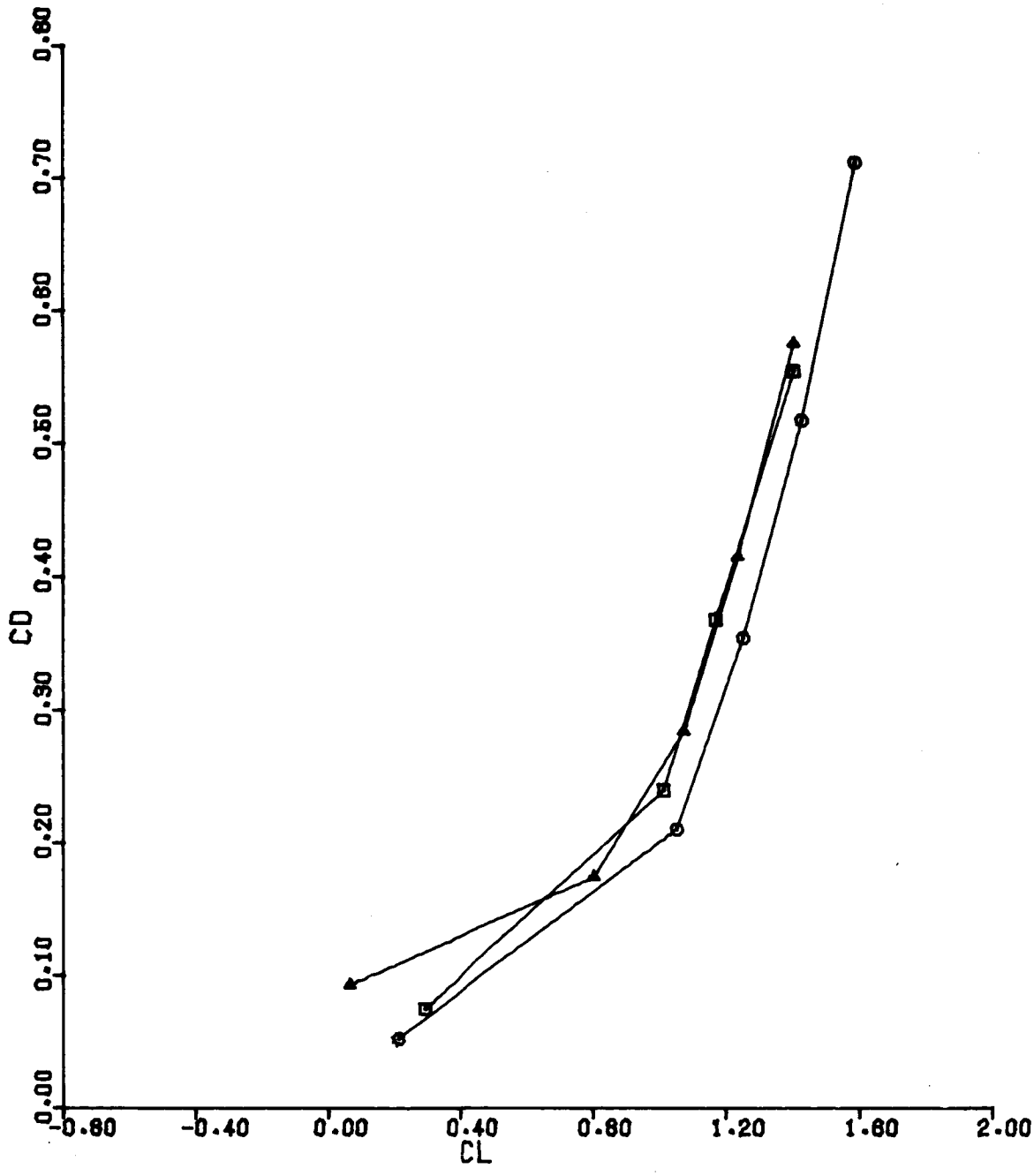

Figure 84(b). CD vs CL
Configuration 9, BETA = 0, MACH = 0.9

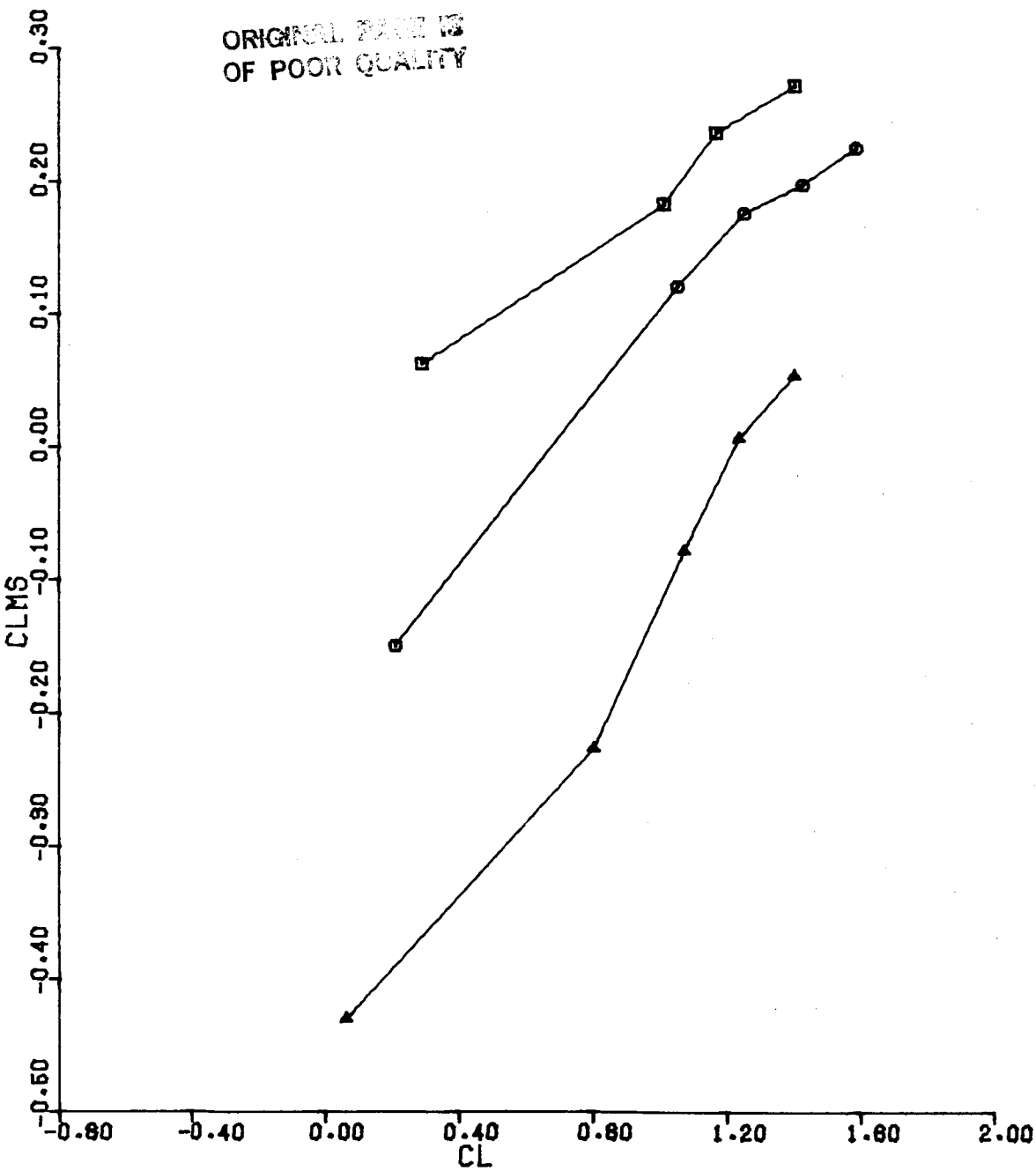

Figure 84(c). CLMS vs CL
Configuration 9, BETA = 0, MACH = 0.9

SYMBOL	RUN	DC
⊡	302	-20
⊙	305	0
▲	308	10

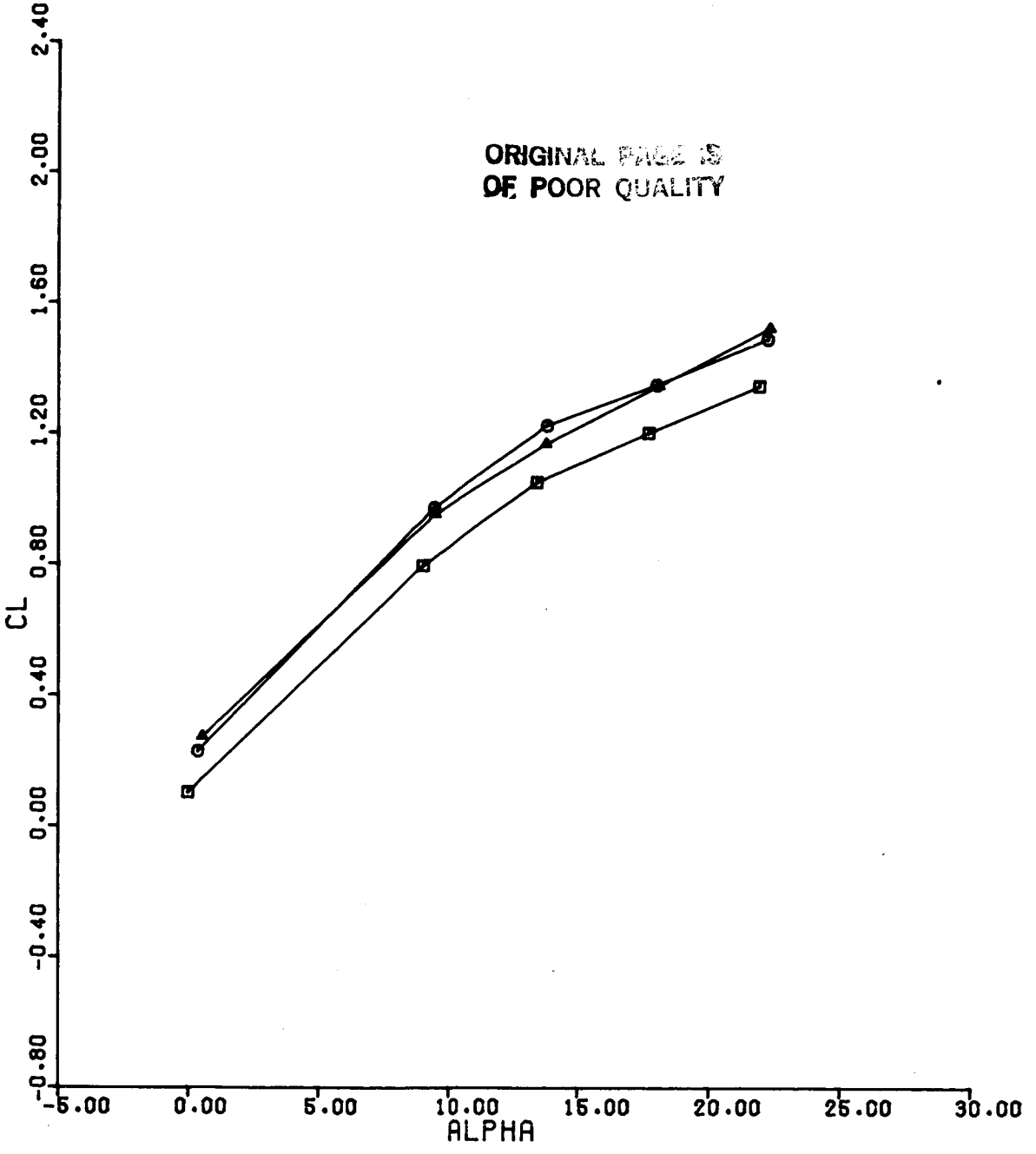

Figure 85(a). CL vs ALPHA
Configuration 9, BETA = 0, MACH = 0.6

SYMBOL	RUN	DC
□	302	-20
○	305	0
△	308	10

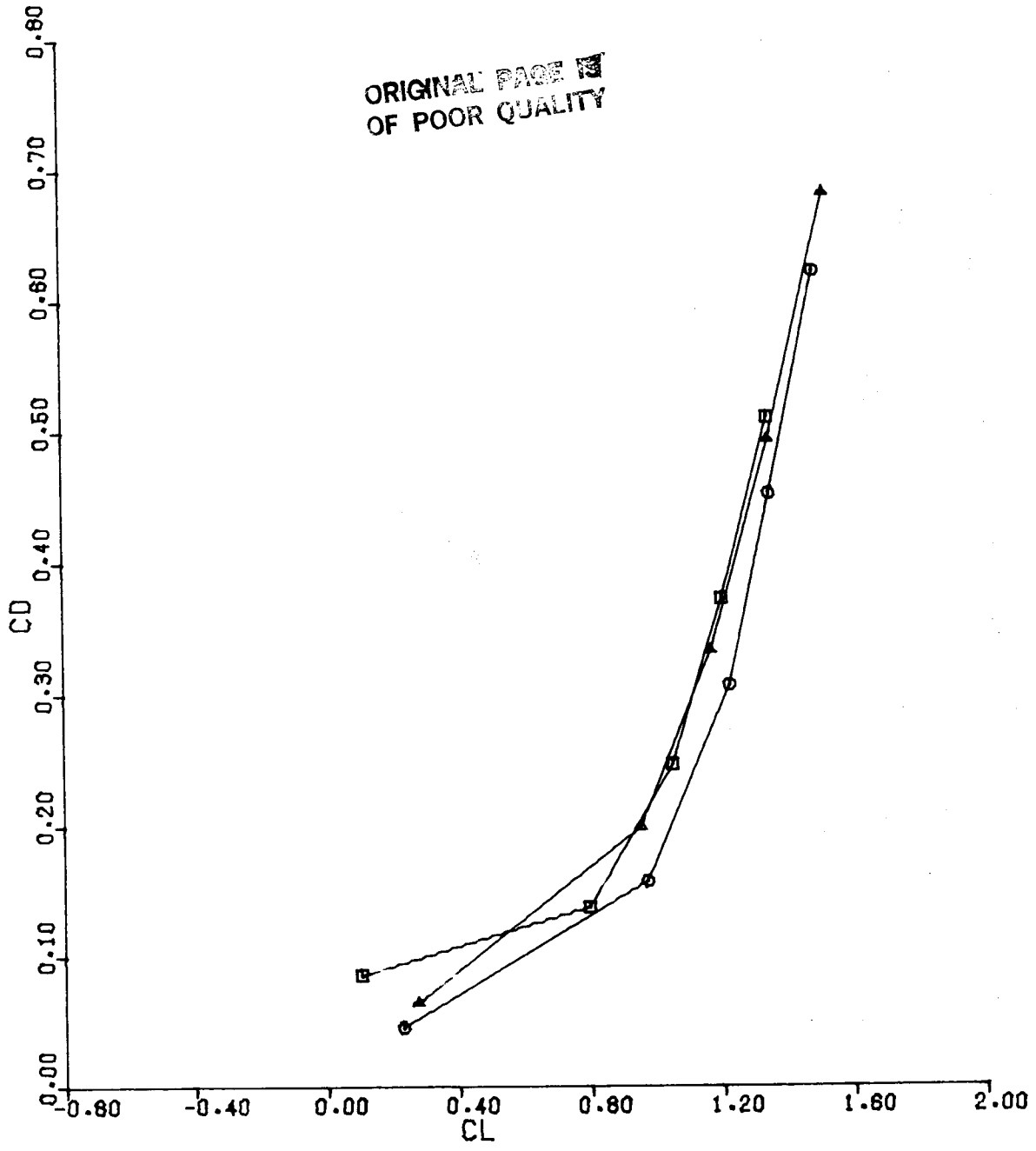

Figure 85(b). CD vs CL
Configuration 9, BETA = 0, MACH = 0.6

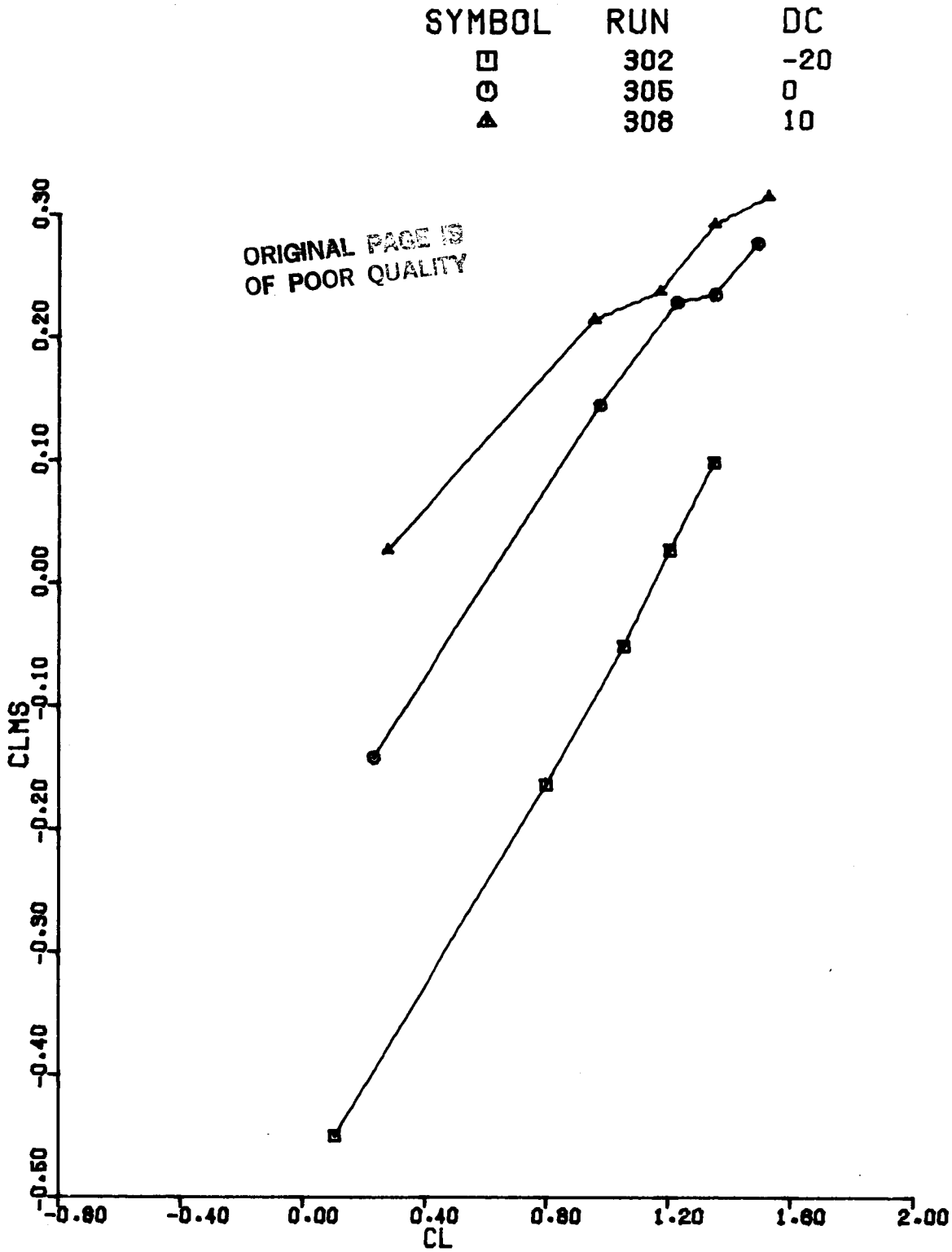

Figure 85(c). CLMS vs CL
Configuration 9, BETA = 0, MACH = 0.6

SYMBOL	RUN	MACH
□	291	1.2
○	296	0.9
△	305	0.6

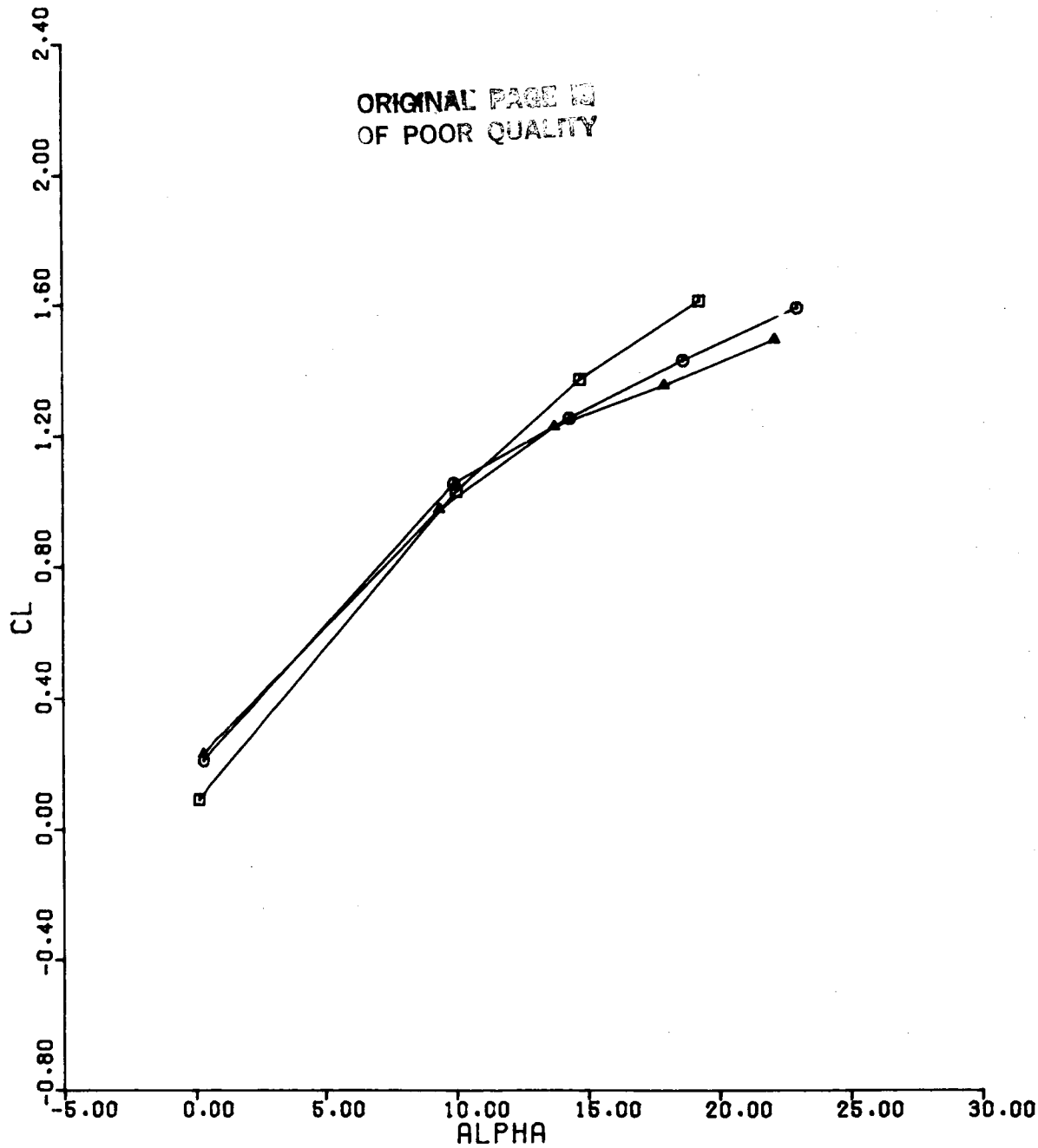

Figure 86(a). CL vs ALPHA
Configuration 9, BETA = 0, DC = 0

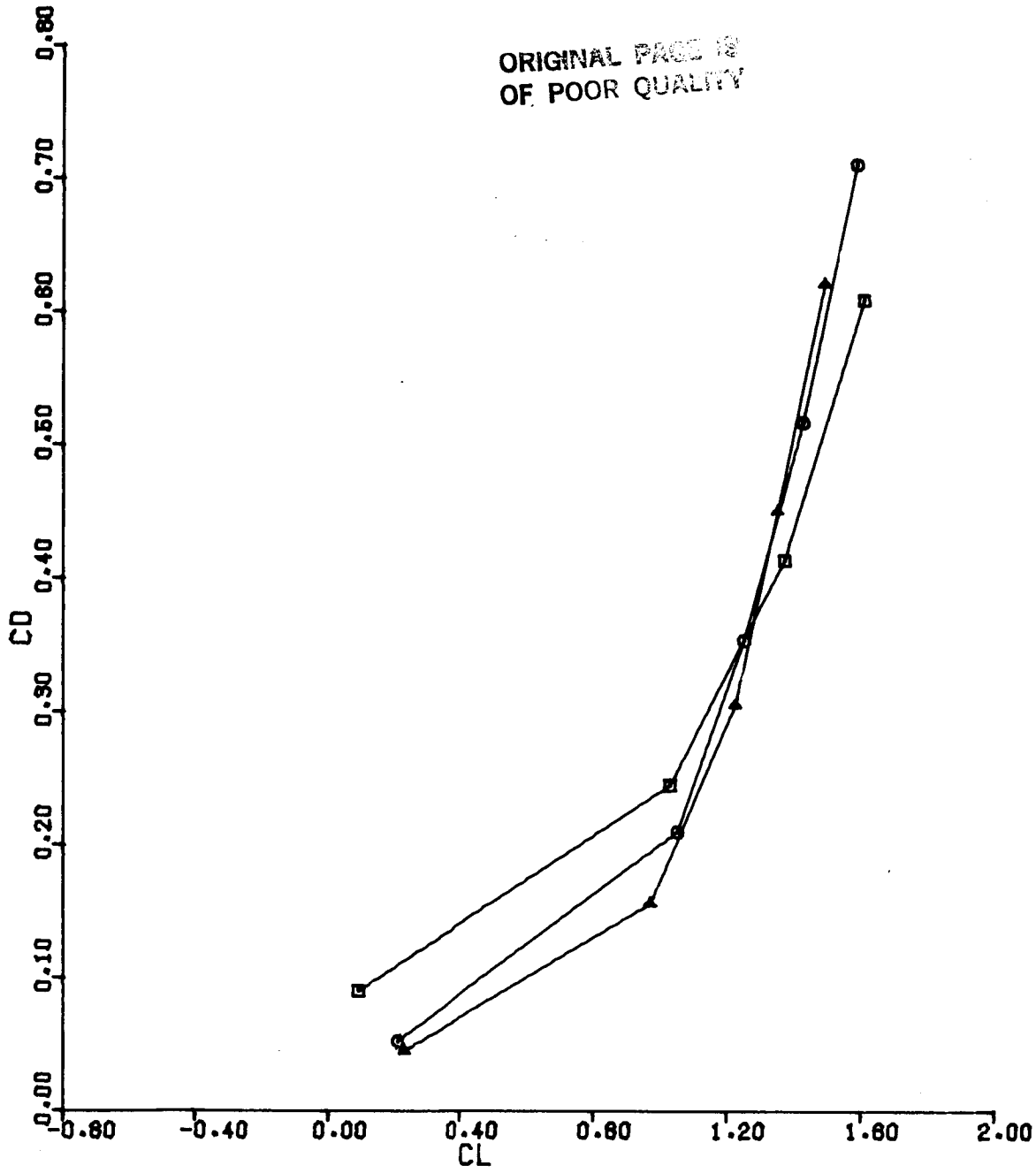

Figure 86(b). CD vs CL
Configuration 9, BETA = 0, DC = 0

SYMBOL	RUN	MACH
□	291	1.2
○	296	0.9
△	305	0.6

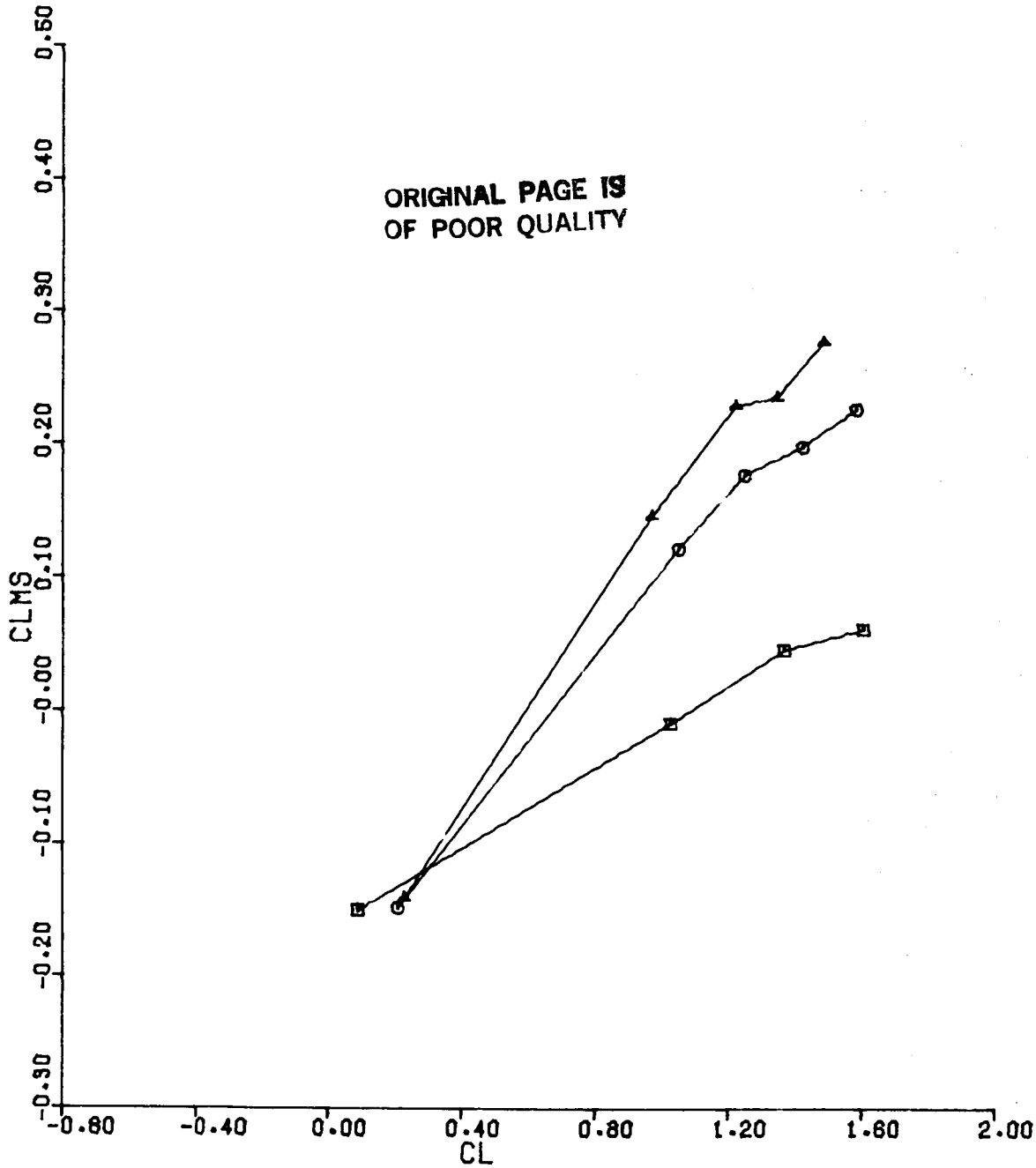

Figure 86(c). CLMS vs CL
Configuration 9, BETA = 0, DC = 0

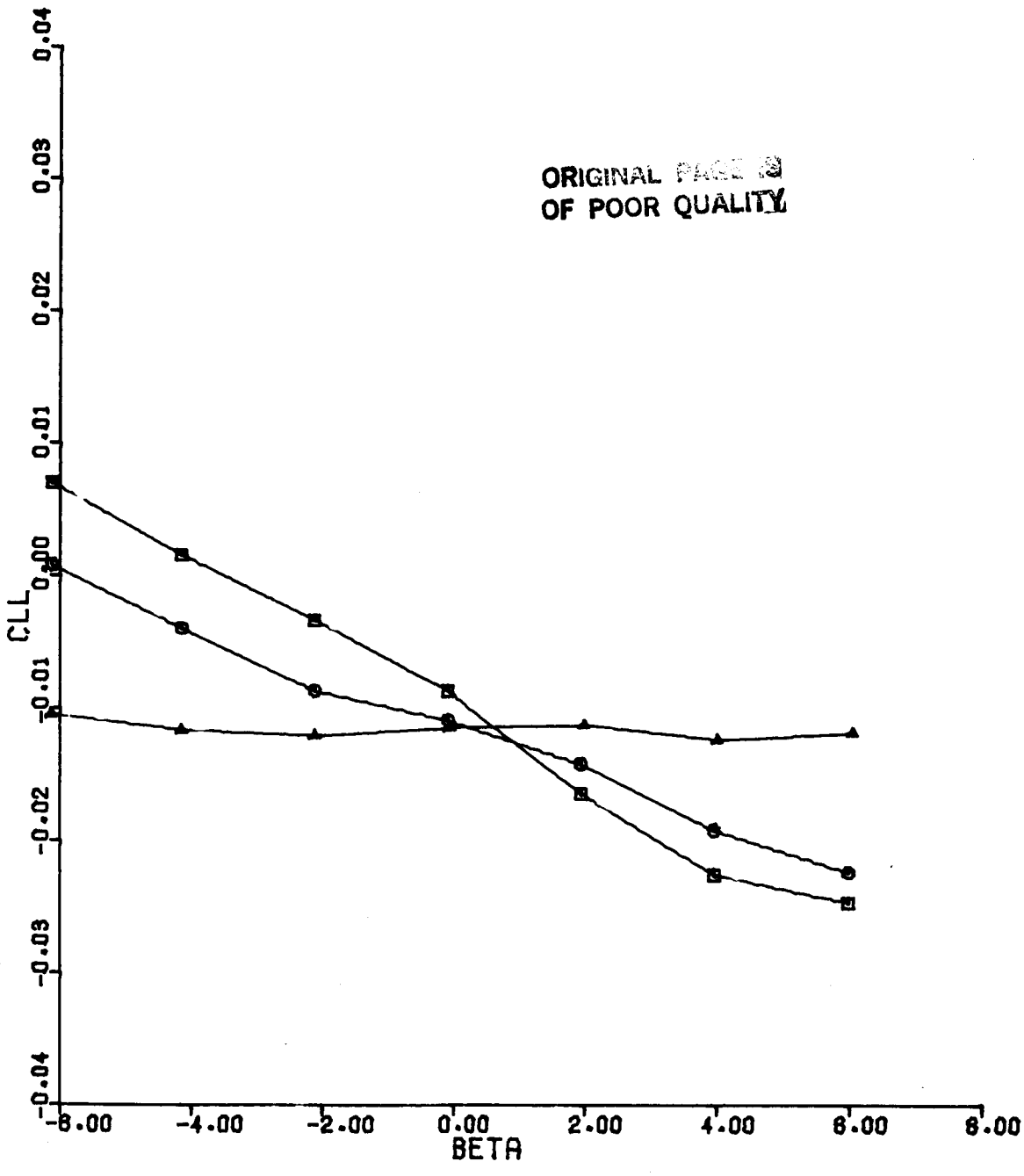

Figure 87(a). CLL vs BETA
Configuration 9, ALPHA = 11, MACH = 0.9

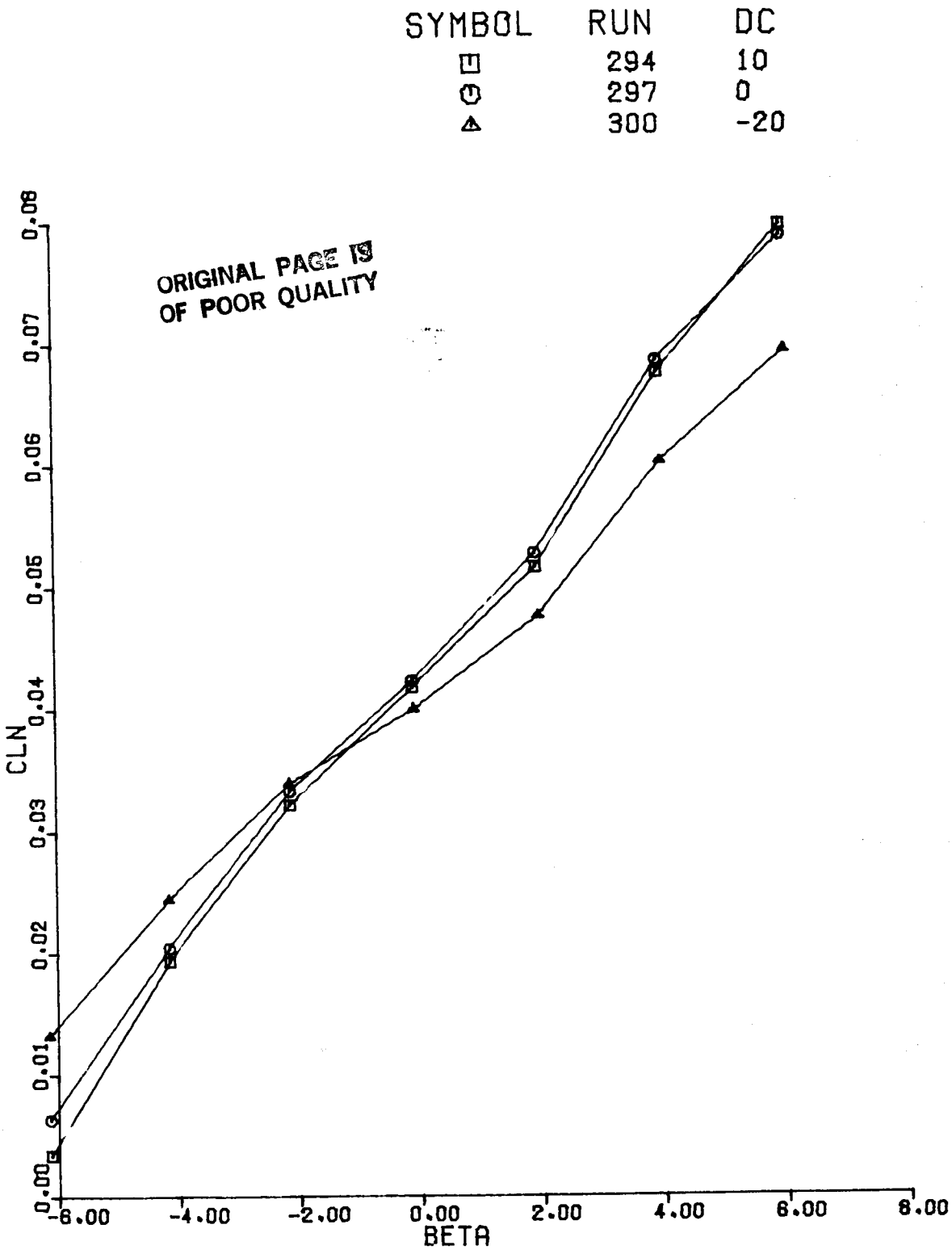

Figure 87(b). CLN vs BETA
Configuration 9, ALPHA = 11, MACH = 0.9

SYMBOL	RUN	DC
□	294	10
○	297	0
△	300	-20

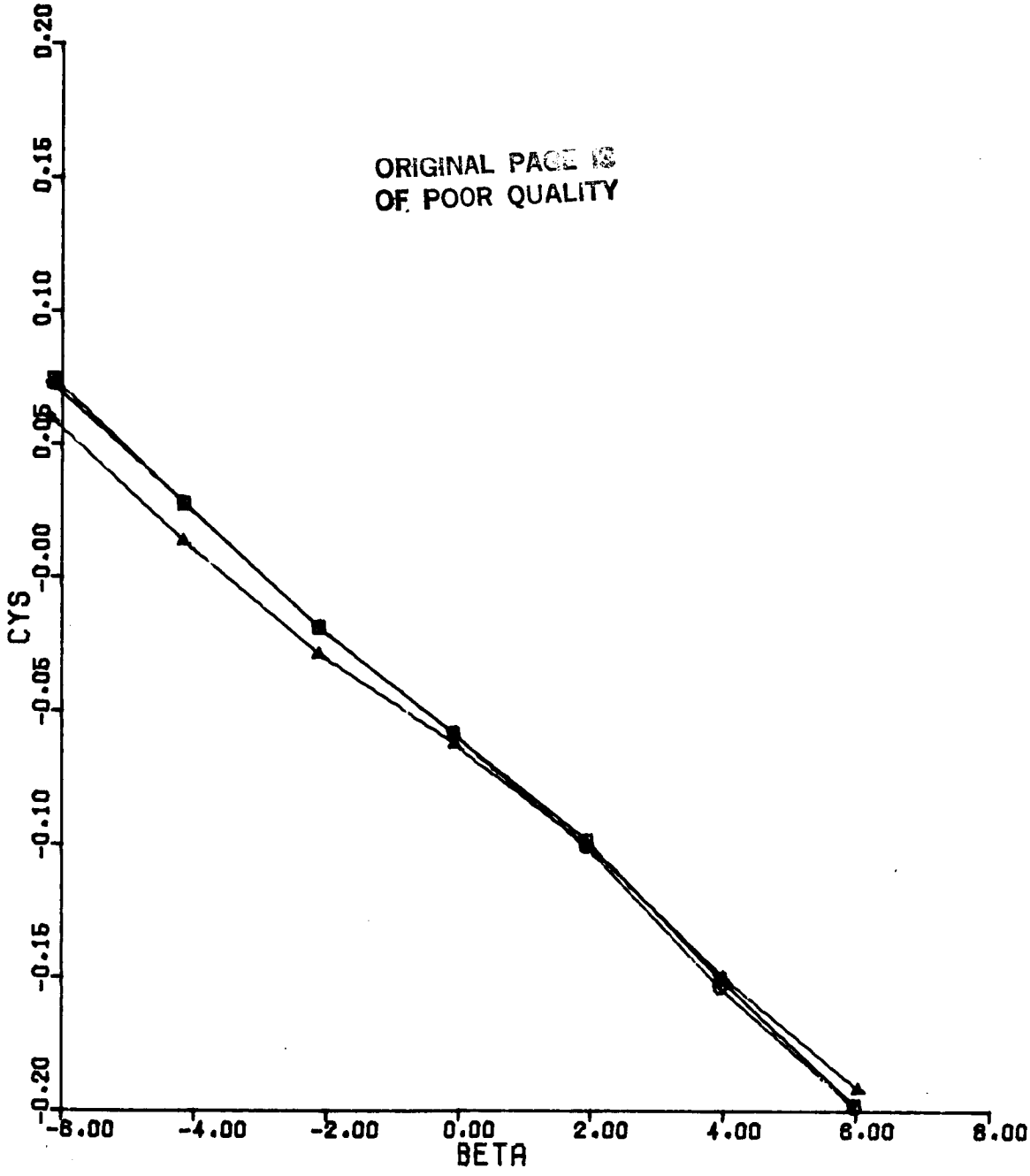

Figure 87(c). CYS vs BETA
Configuration 9, ALPHA = 11, MACH = 0.9

SYMBOL	RUN	DC
□	295	10
○	298	0
△	301	-20

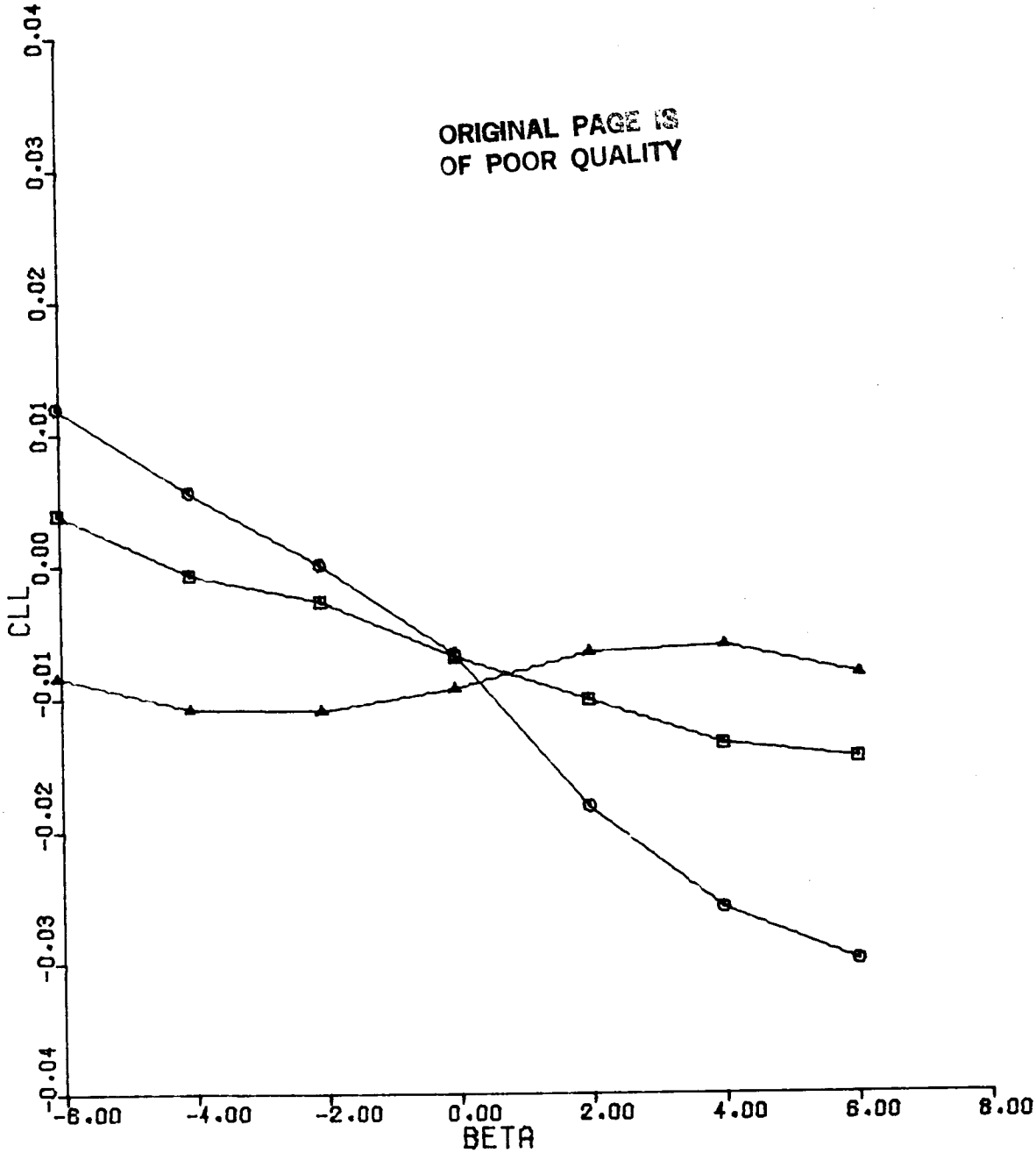

Figure 88(a). CLL vs BETA
Configuration 9, ALPHA = 16, MACH = 0.9

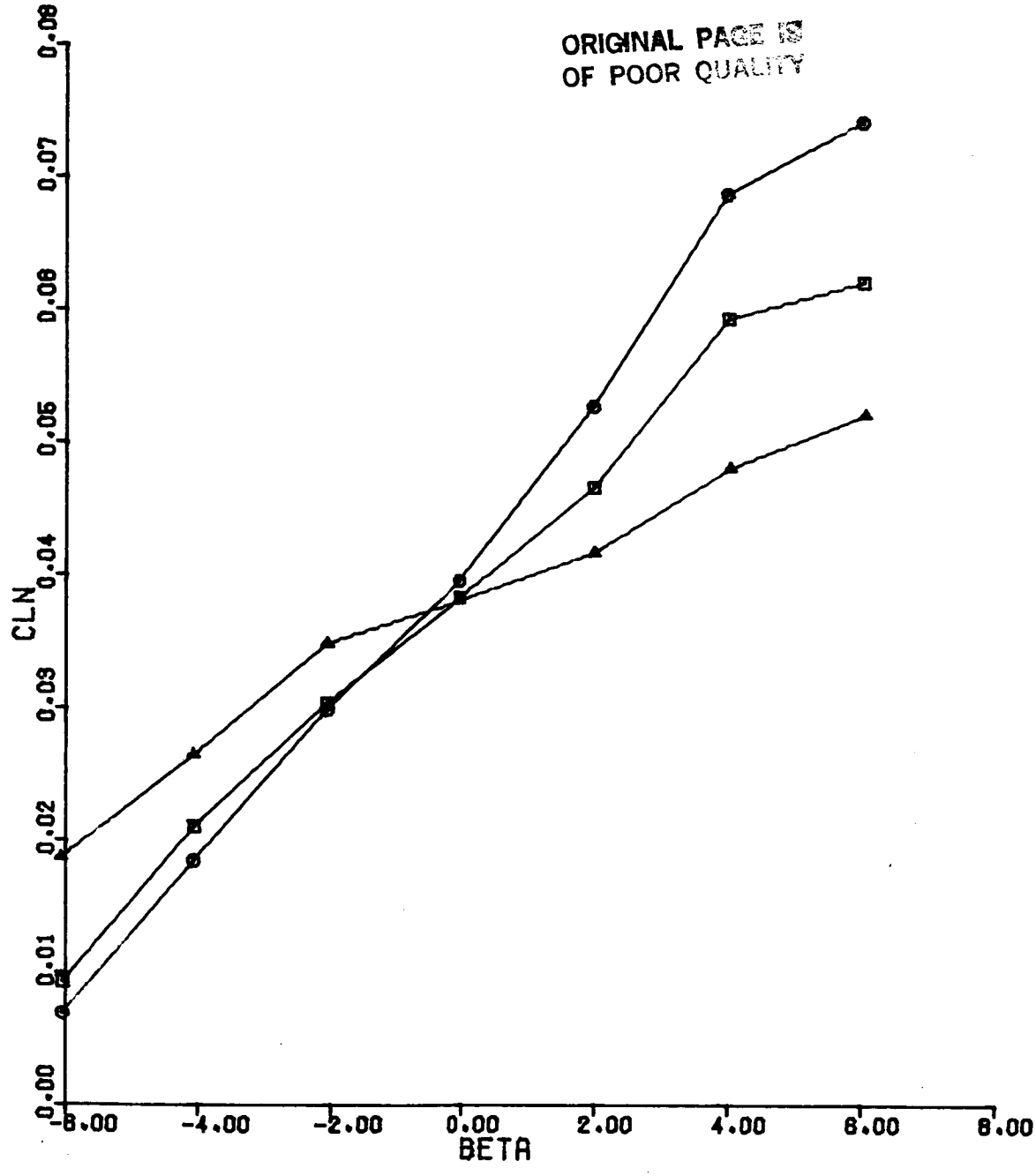

Figure 88(b). CLN vs BETA
Configuration 9, ALPHA = 16, MACH = 0.9

SYMBOL	RUN	DC
□	295	10
○	298	0
△	301	-20

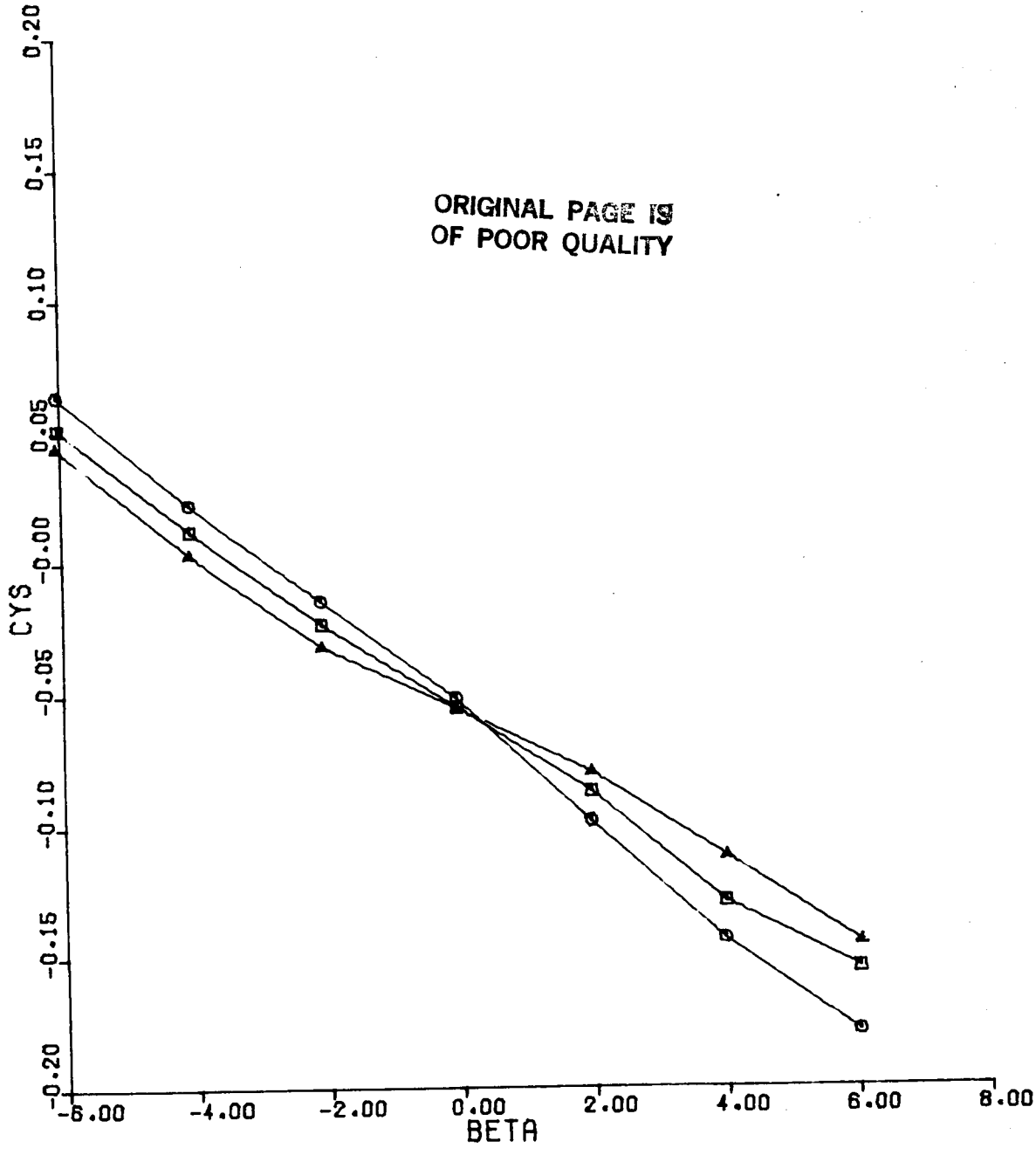

Figure 88(c). CYS vs BETA
Configuration 9, ALPHA = 16, MACH = 0.9

SYMBOL	RUN	DC
□	303	-20
○	306	0
△	309	10

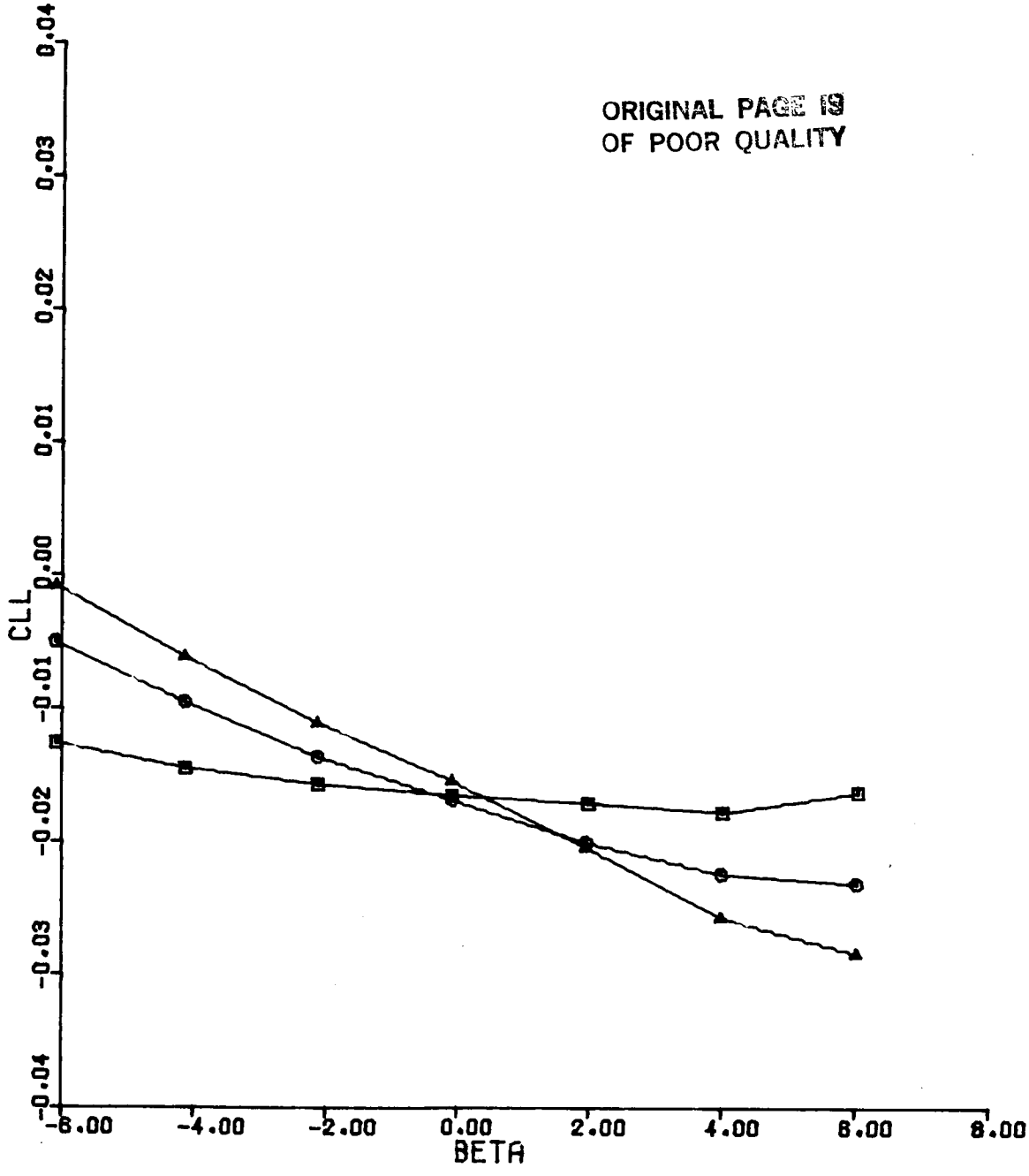

Figure 89(a). CLL vs BETA
Configuration 9, ALPHA = 10, MACH = 0.6

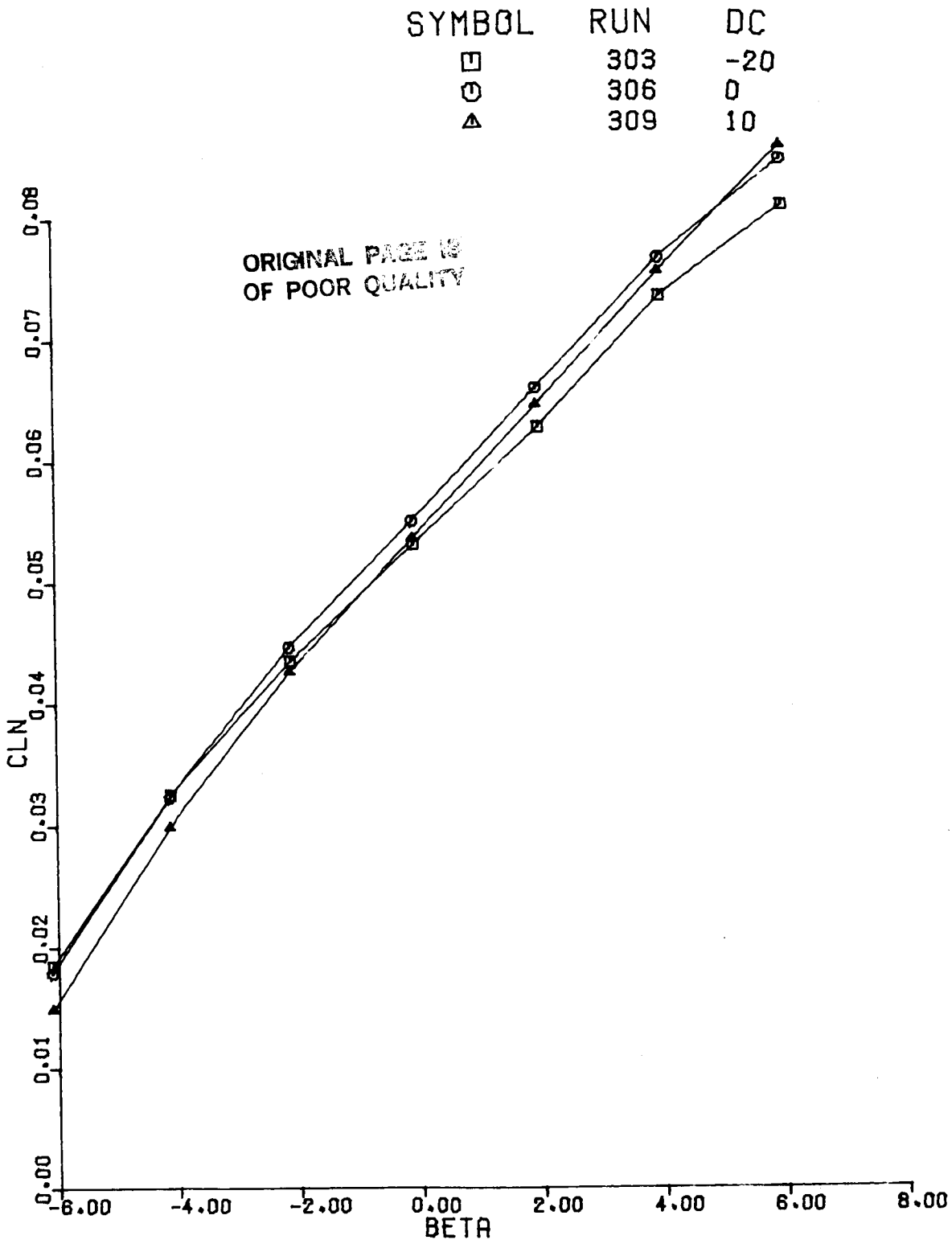

Figure 89(b). CLN vs BETA
Configuration 9, ALPHA = 10, MACH = 0.6

SYMBOL	RUN	DC
□	303	-20
○	306	0
△	309	10

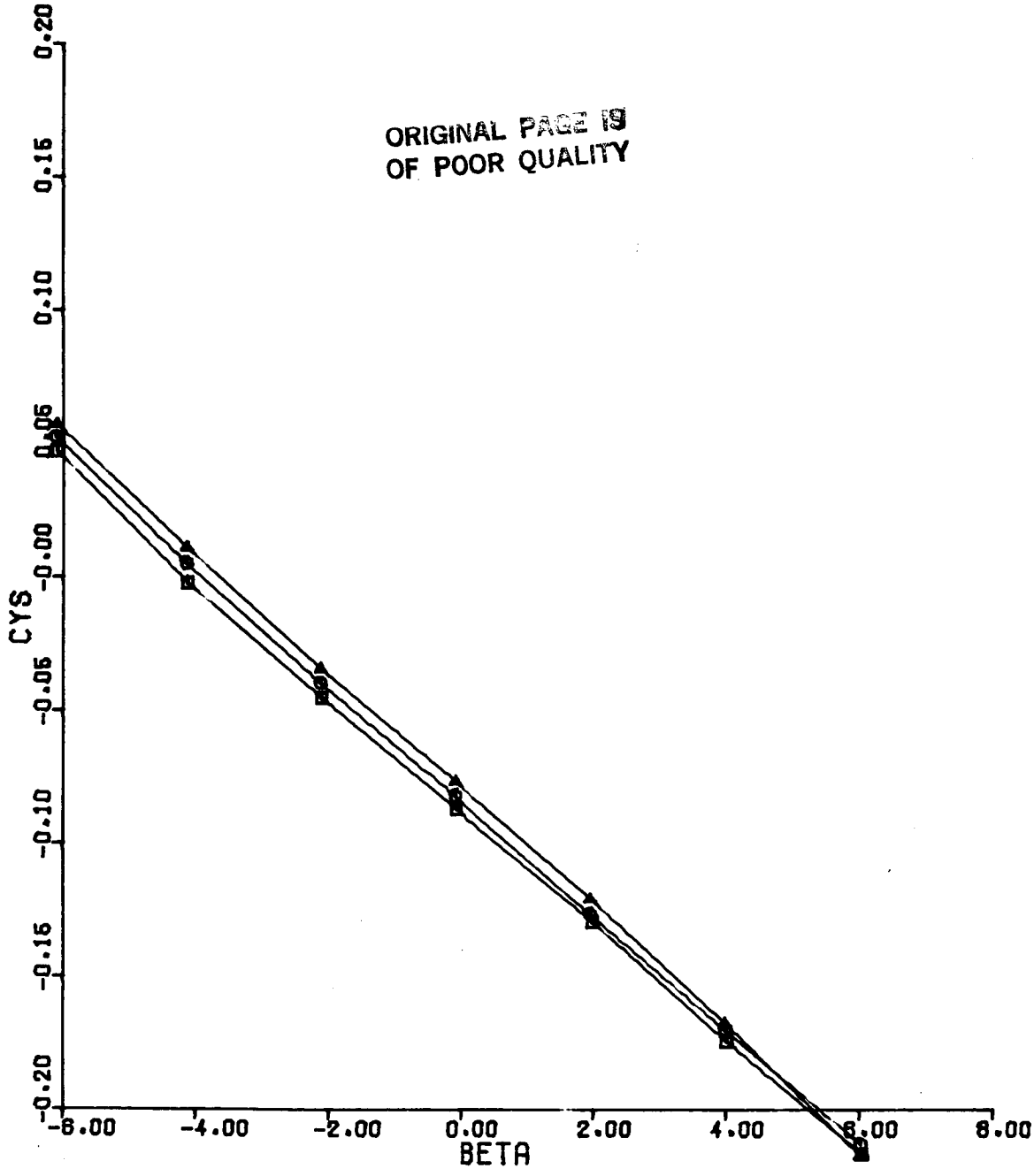

Figure 89(c). CYS vs BETA
Configuration 9, ALPHA = 10, MACH = 0.6

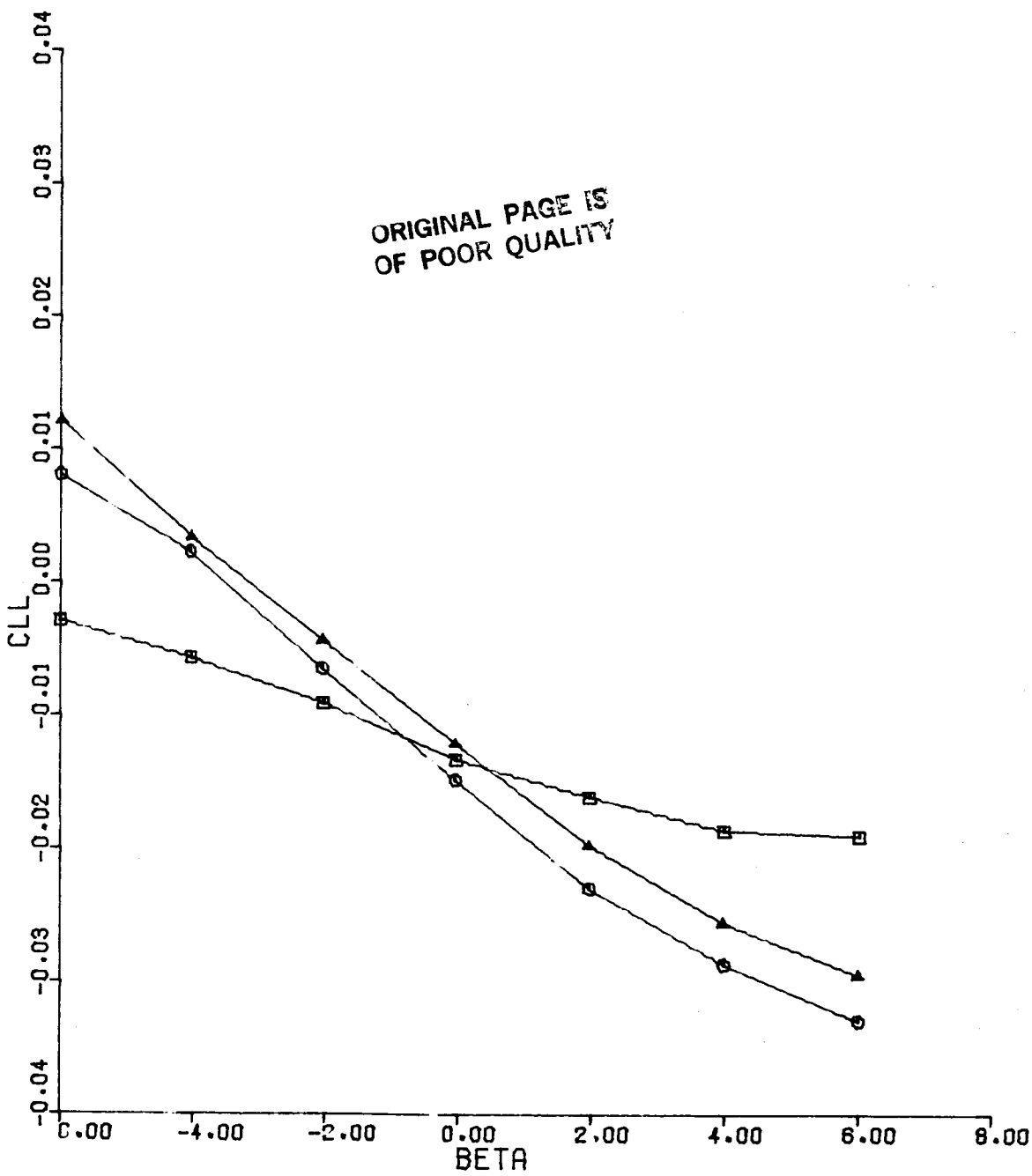

Figure 90(a). CLL vs BETA
Configuration 9, ALPHA = 15, MACH = 0.6

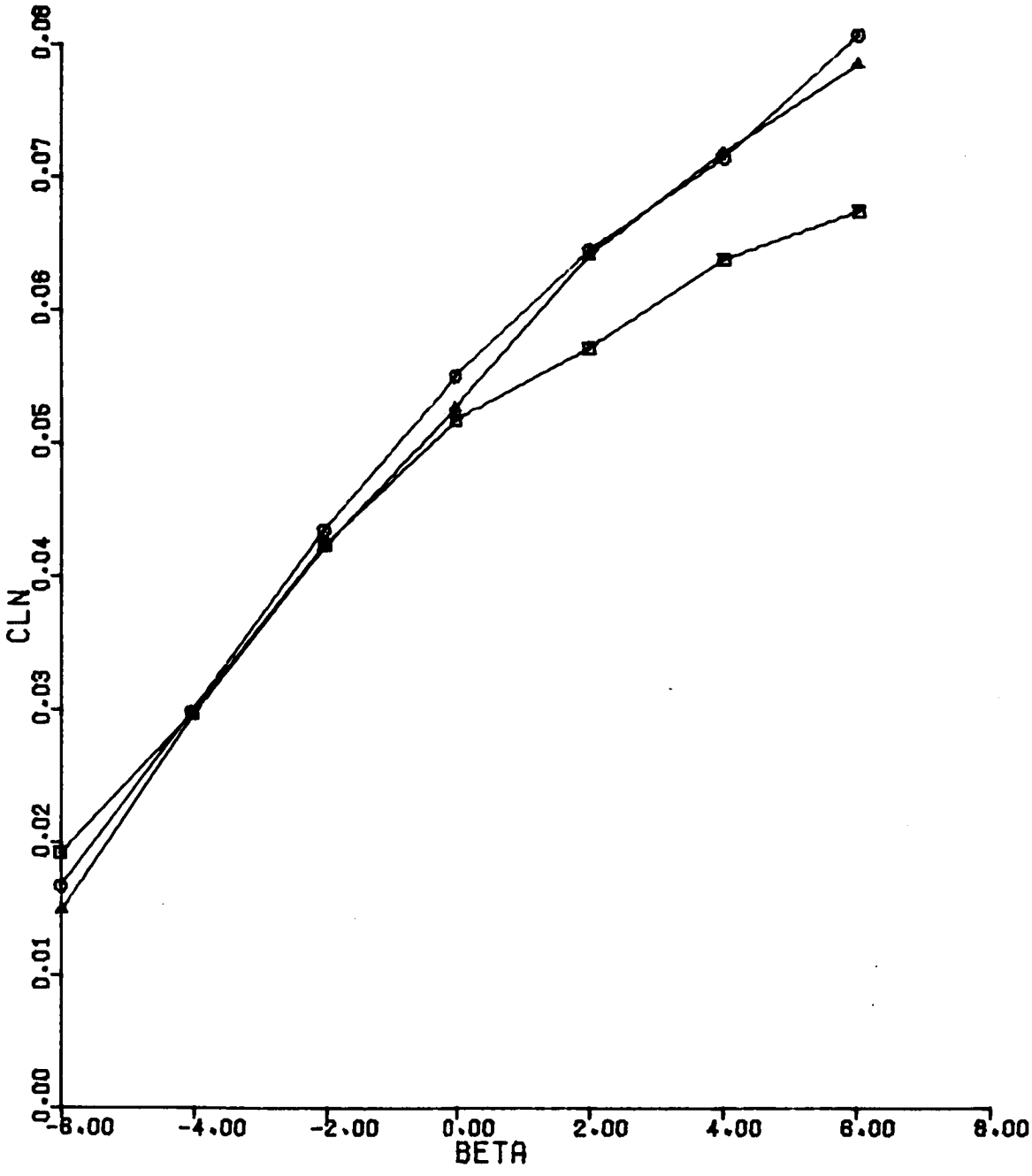

Figure 90(b). CLN vs BETA
Configuration 9, ALPHA = 15, MACH = 0.6

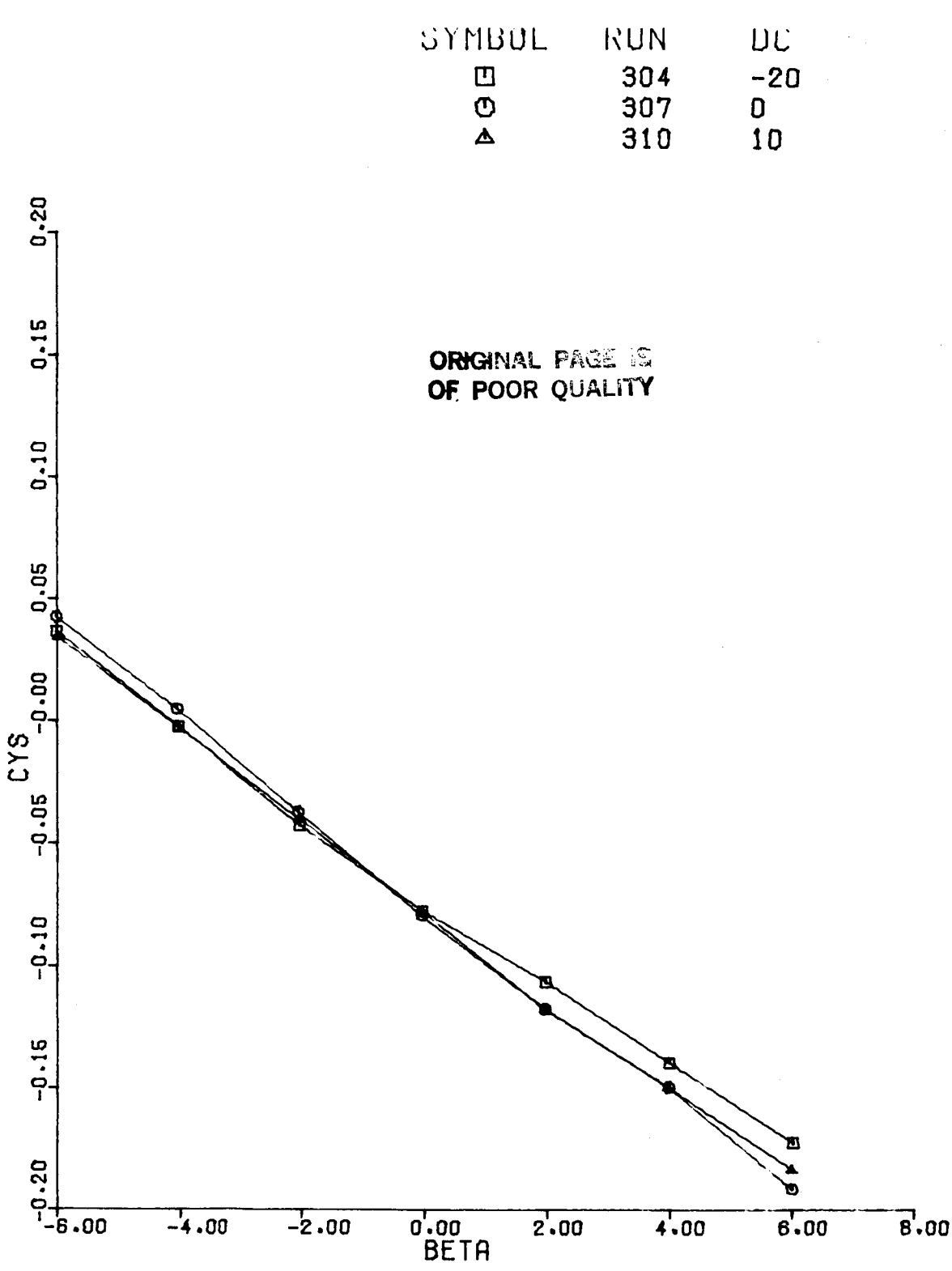

Figure 90(c). CYS vs BETA
Configuration 9, ALPHA = 15, MACH = 0.6

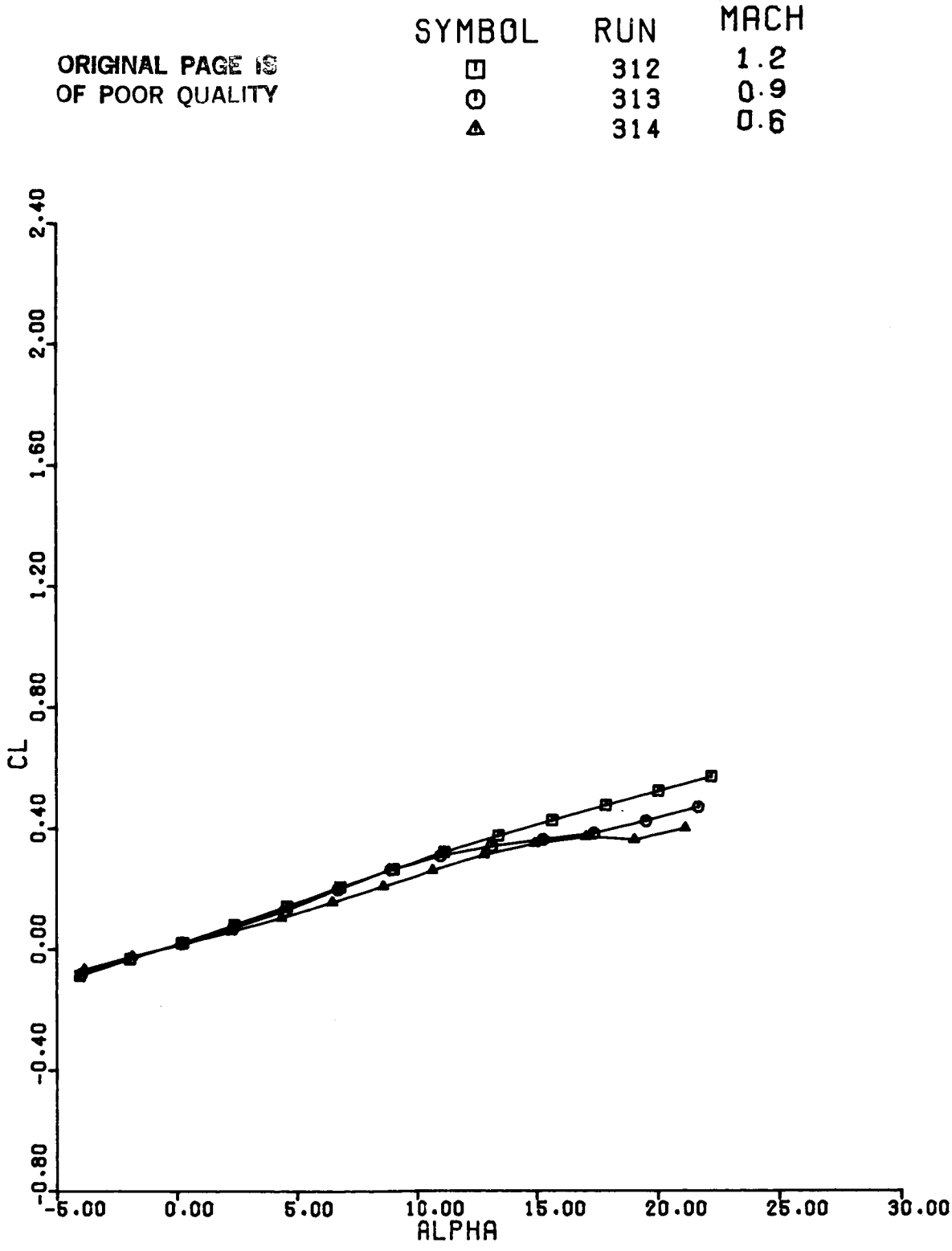

Figure 91(a). CL vs ALPHA
Configuration 10, BETA = 0, DC = 0

SYMBOL	RUN	MACH
□	312	1.2
○	313	0.9
△	314	0.6

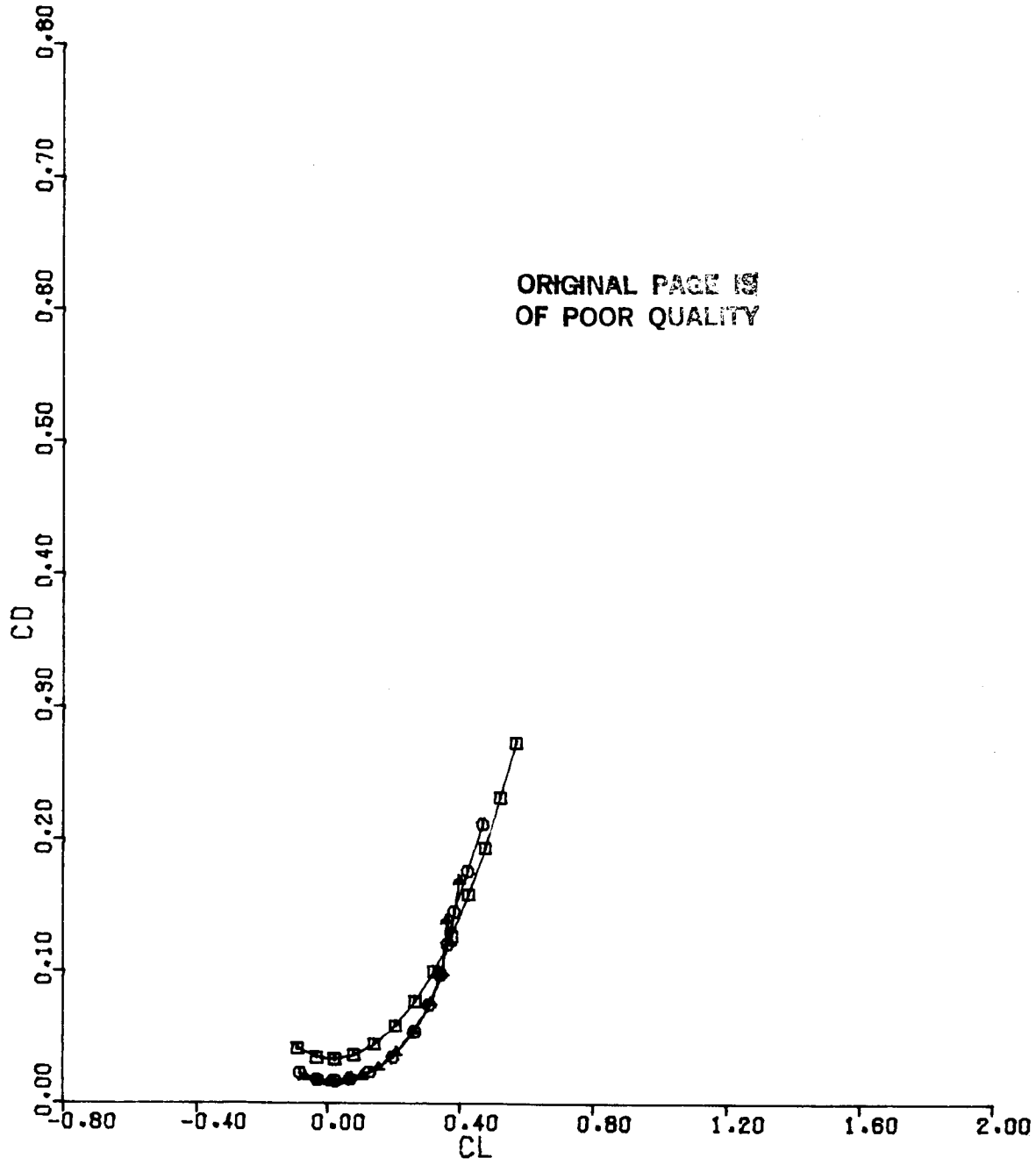

Figure 91(b). CD vs CL
Configuration 10, BETA = 0, DC = 0

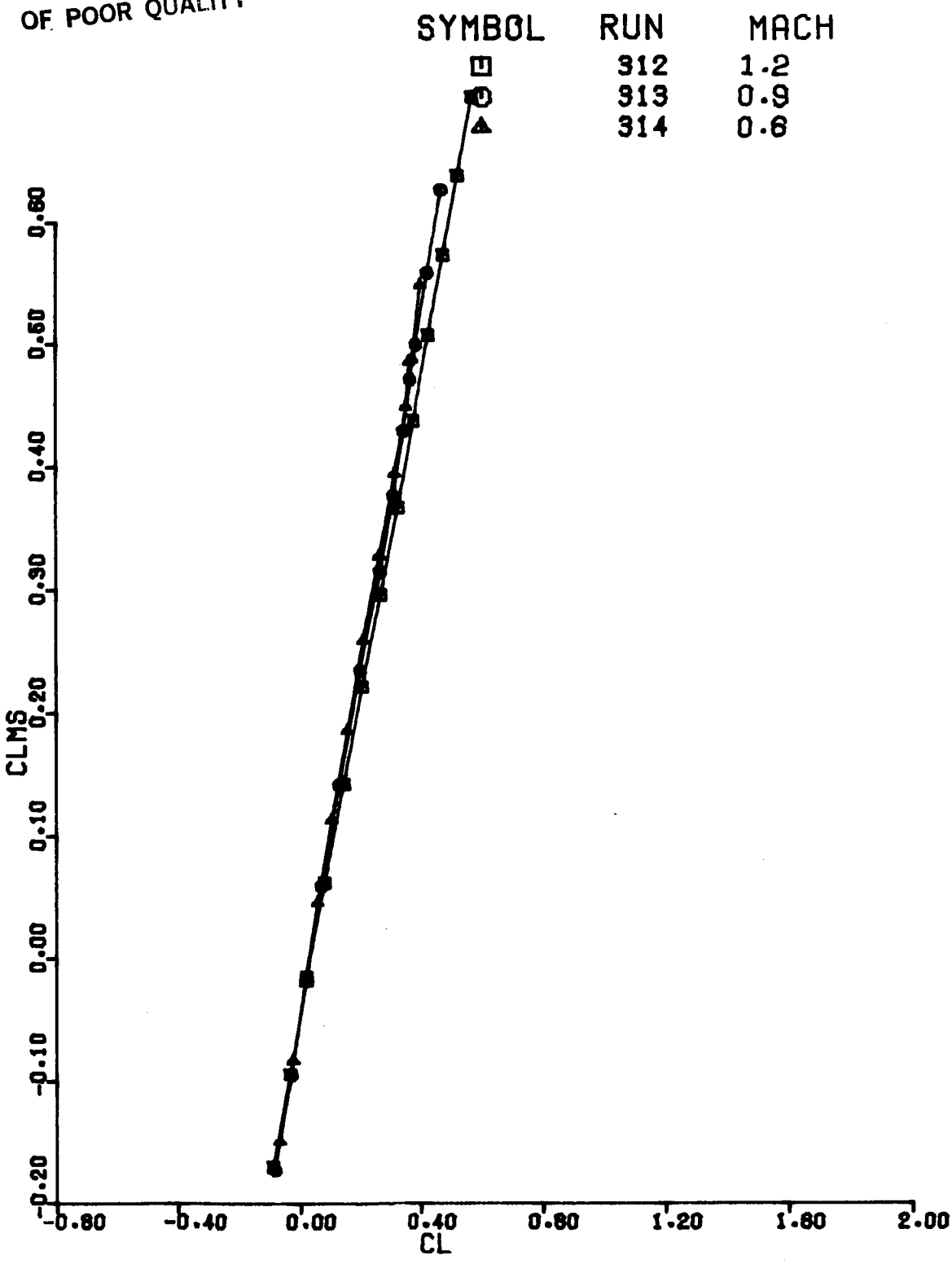

Figure 91(c). CLMS vs CL
Configuration 10, BETA = 0, DC = 0

SYMBOL	RUN	MACH
□	316	1.2
○	317	0.9
△	318	0.6

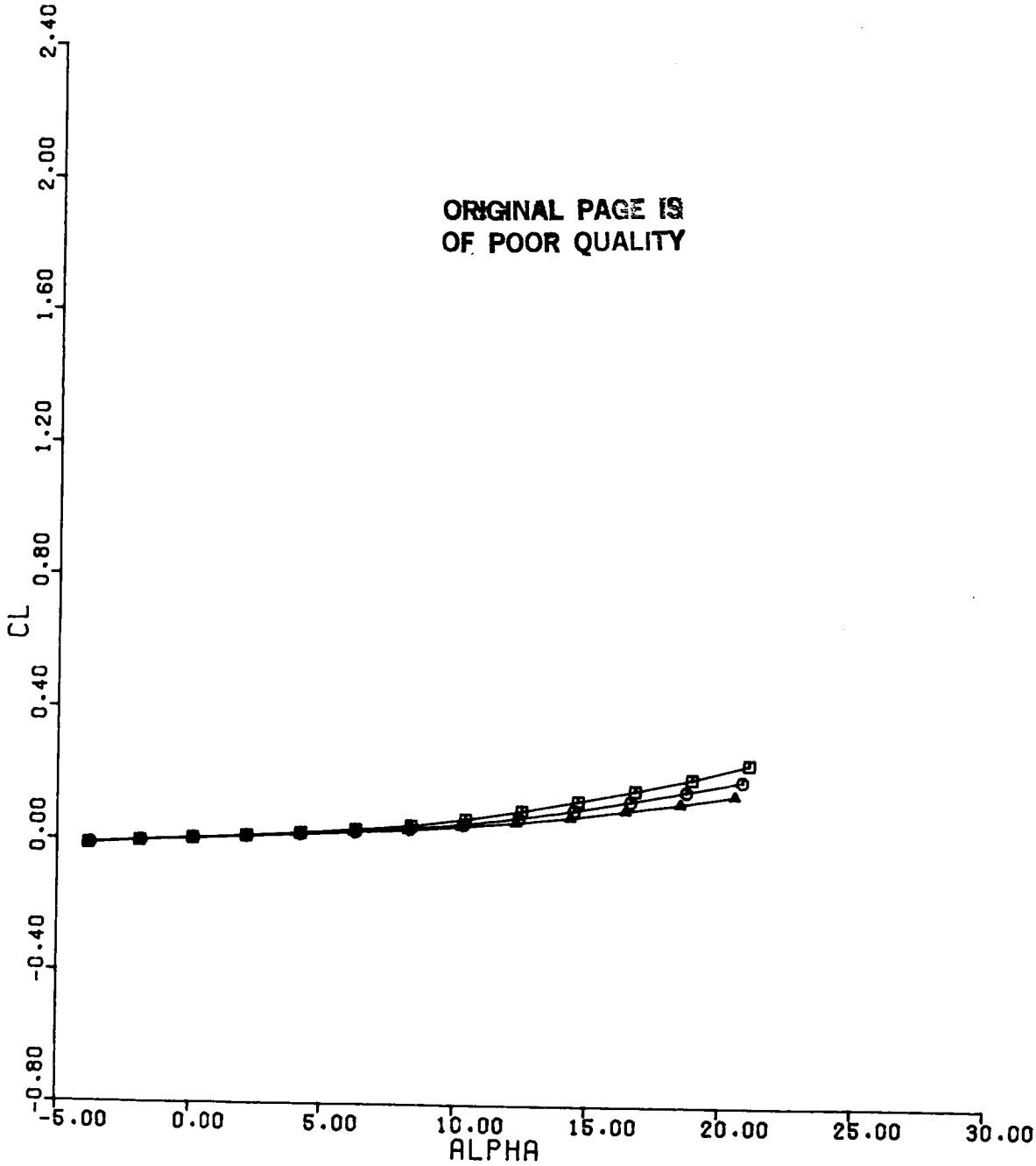

Figure 92(a). CL vs ALPHA
Configuration 11, BETA = 0

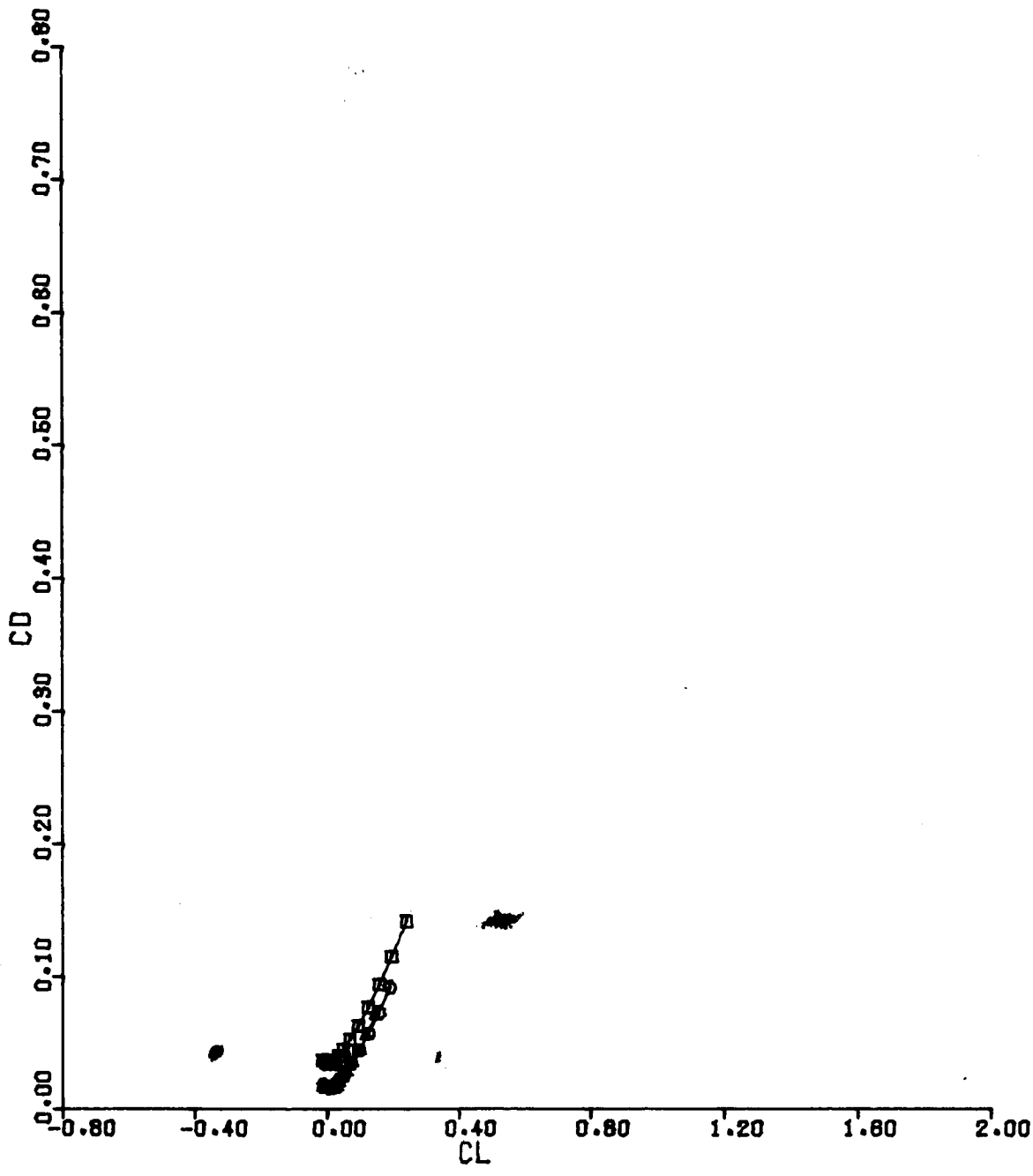

Figure 92(b). CD vs CL
Configuration 11, BETA = 0

SYMBOL	RUN	MACH
□	316	1.2
○	317	0.9
△	318	0.6

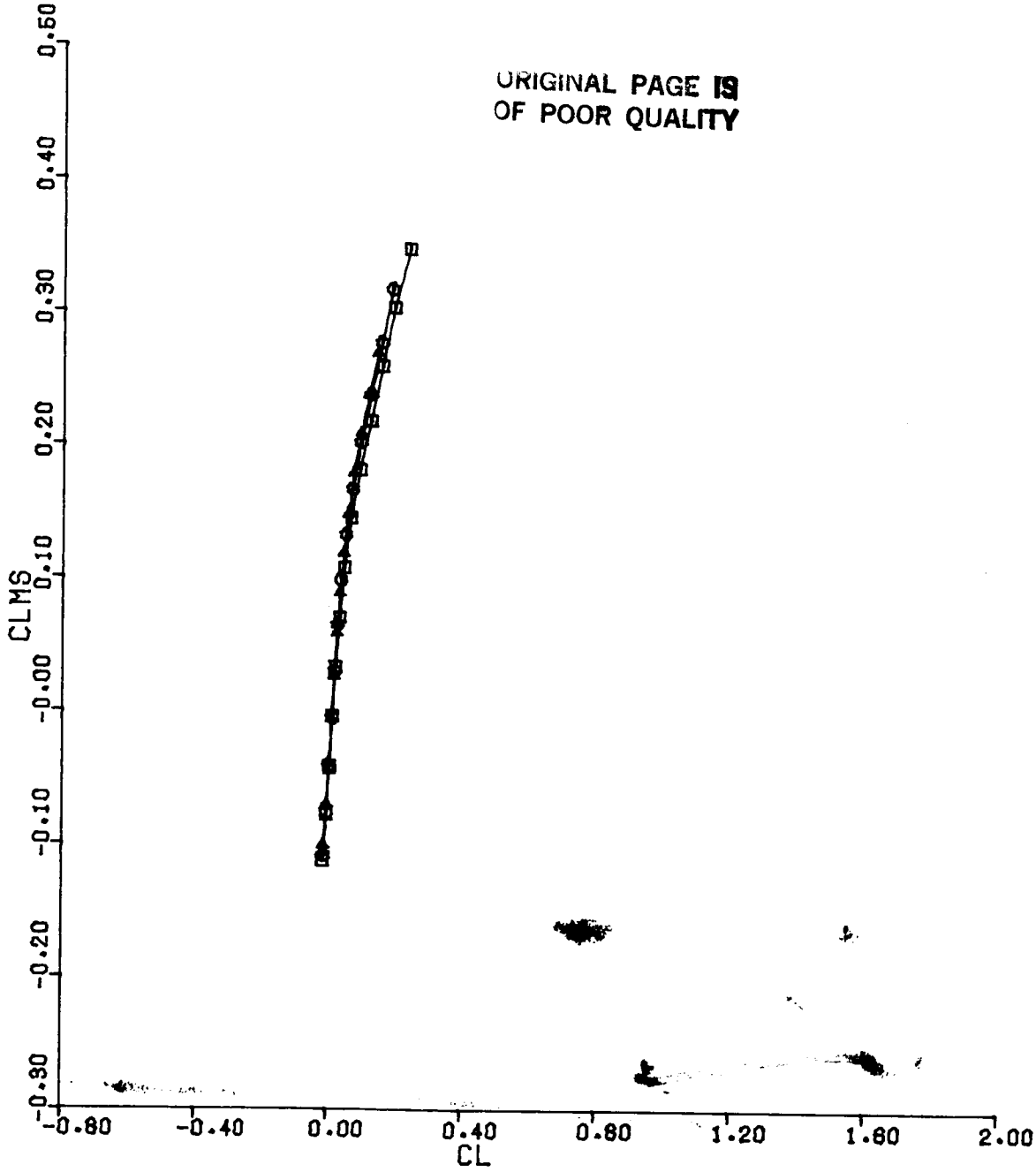

Figure 92(c). CLMS vs CL
Configuration 11, BETA = 0

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15. Supplementary Notes

16. Abstract

Aerodynamic data from NASA Ames Research Center's 11-Foot Transonic Wind Tunnel are plotted for the 1/8-scale X-29A forward-swept wing aircraft model. Eleven configurations were tested to provide supplemental data to investigate single surface failure modes, complex nonlinearities, and model buildup.

These data can be used for control system refinements, pilot training, flight planning, and aerodynamic model validation. Data are presented as corrected wind tunnel data without analysis to document results that are being used for the aerodynamic model.

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